Westinghouse Electric Corporation

Westinghouse Electric Corporation

P R O P O S A L

10-KW FM TRANSMITTER

AND

AUXILIARY EQUIPMENT

SUBMITTED TO

INTERNATIONAL BROADCASTING CORP.

SHREVEPORT, LA.

SUBMITTED BY:

WESTINGHOUSE ELECTRIC CORPORATION

SHREVEPORT, LA.

NEG.# 49190

WESTINGHOUSE
ELECTRIC CORPORATION

MA JH 2 19

To NATIONAL BOADCASTING CORP.
(Hereinafter called the Purchaser)

P. O. Address COMMERCIAL JILDING,

Shipping Address SHREVEPORT, LA

Westinghouse Electric Corporation (hereinafter called the Company or Corporation) proposes to deliver f. o. b. point of shipment the apparatus described herein:

Item #1 - One (1) Westinghouse type FM-10, 10 KW FM Broadcast Transmitter, in accordance with Descriptive Specifications R-1702 and R1508-A, consisting of the following.

a. Three-cubicle transmitter with duplicate crystal oscillators (one operating and one spare) and one set of instruction books.

b. One set of operating tubes

c One complete set of spare tubes.

Net Price - - - - $22,700.00
F.O.B. Lansdowne, Maryland.

Note #1.

The type FM-10 transmitter consists of the type FM-3 transmitter (which serves as a driver) and two matching cubicles which house the 10 KW Power Amplifier and 10 KW Rectifier. A sub-base assembly will be supplied to facilitate mounting the three cubicles for "in-line" installations. As an alternate, the Rectifier Cubicle may be installed remote from the Driver and Power Amplifier; and in such cases appropriate end radii will be supplied in lieu of the ub base assembly.

WESTINGHOUSE
FORM 15499-C
THREE SHEETS,
SHEET 1
PRINTED IN U.S.A.

Note #2:

Included in the above net price are the services of an engineer for final tune-up placing the station on the air and instructing the station personnel in the operation of the transmitter.

Paragraph "A"

The liability of the Company, as defined elsewhere in this contract, for patent infringement by the apparatus, or any part thereof, shall be limited as follows:

It is the practice of Major E. H. Armstrong to license the broadcaster (instead of the manufacturer of radio broadcast transmitting apparatus) under his patents relating to frequency modulation. Protection of the customer, therefore, under such patents of Major Armstrong covering the apparatus, its method of operation, or any part thereof, is not assumed by the Company.

1. The Corporation warrants that the apparatus to be delivered hereunder shall be of the kind and quality described in the specifications and no other warranty, except of title, shall be implied. The conditions of any tests shall be mutually agreed upon and the Corporation shall be notified of and may be represented at all tests that may be made. If any failure to comply with the specifications appears within one year from the date of shipment, the Purchaser shall notify the Corporation thereof immediately and the Corporation shall thereupon correct the defect, or defects, by repair, or by replacement f.o.b. factory of the defective part or parts. But if the apparatus is installed or its installation supervised by the Corporation, said one year shall run from the completion of installation provided same is not unreasonably delayed by the Purchaser. The liability of the Corporation (except as to title) arising out of the supplying of said apparatus, or its use, whether on warranties or otherwise, shall not in any case exceed the cost of correcting defects in the apparatus and, upon the expiration of said one year all such liability shall terminate.

2. The Corporation shall defend any suit or proceeding brought against the Purchaser so far as based on a claim that any apparatus, or any part thereof, furnished under this contract constitutes an infringement of any patent of the United States, if notified promptly in writing and given authority, information and assistance (at the Corporation's expense) for the defense of same, and the Corporation shall pay all damages and costs awarded therein against the Purchaser. In case the said apparatus or any part thereof is in such suit held to constitute infringement and the use of said apparatus or part is enjoined, the Corporation shall, at its own expense, either: procure for the Purchaser the right to continue using said apparatus or part; or replace same with non-infringing apparatus; or modify it so it becomes non-infringing; or remove said apparatus and refund the purchase price and the transportation and installation costs thereof. The foregoing states the entire liability of the Corporation for patent infringement by said apparatus or any part thereof.

3. The title to the apparatus herein specified, and any replacements thereof or substitutions therefor, shall not pass from the Corporation until all payments due hereunder (including deferred payments and payments of notes and renewals thereof if any) shall have been fully made in cash, and the apparatus specified shall remain personal property whatever may be the mode of its attachment to the realty or other property, until fully paid for in cash, and the Purchaser agrees to perform all acts which may be necessary to perfect and assure retention of title to the said apparatus in the Corporation. The Purchaser shall assume all risk of loss after the apparatus is delivered as specified herein. If default is made in any of the payments, in the manner and form and at the time herein specified, the Corporation shall be entitled to the immediate possession of said apparatus and shall be free to enter the premises where such apparatus may be located and remove the same as its property, without prejudice to any further damages which the Corporation may suffer by reason of the Purchaser's refusal or failure to surrender the apparatus when so required. In case notes or trade acceptances are accepted, they shall be mere evidence of indebtedness and not payment and if any one is not paid when due, all outstanding notes shall, at the option of the holder, become immediately due and payable; all collection and exchange charges and all taxes shall be payable by the Purchaser.

4. Price TWENTY O HUNDRED AND No/100 - - - - -

- - Dollars, ($2,700.00)

Payable in United States currency.

An extra charge will be made for special containers (such as oil barrels, reels, etc.), but refund will be made if returned in good condition to the factory, or other point designated by the Corporation, within ninety (90) days from date of original shipment, charges prepaid.

5. TERMS OF PAYMENT:

XX 50 ~~per cent~~ Sight ~~Draft attached to Bill~~ of Lading. See Terms on Sheet 4
XX 40 ~~per cent~~ 30 days from date of Bill of Lading.
XX 10 per cent 60 days from date of Bill of Lading.

The Corporation reserves the right to ship to its order and make full collection of the contract price by sight draft with Bill of Lading attached.

If, in the judgment of the Corporation, the financial condition of the Purchaser, at any time during the manufacturing period, or at the time apparatus is ready for shipment does not justify the terms of payment specified above, the Corporation has the right to require full payment in cash before continuing manufacture or making shipment.

Pro rata payments shall become due as shipments are made. If shipments are delayed by the Purchaser, payments shall become due from date when the Corporation is prepared to make shipment. If manufacture is delayed by the Purchaser, payment shall be made based on the contract price and per cent of completion. Apparatus held for the Purchaser shall be at the risk and expense of the Purchaser.

5. TERMS OF PAYMENT (CONTINUED)

One-third of total contract price with execution of this contract. This equals

$7,566.67

One-third at date of Bill of Lading covering final shipment.

One-third (or balance due) 30 days after date of Bill of Lading.

6. Shipment of the apparatus described herein will be made as follows;

The above shipping dates are approximate and include.....days for Purchaser to furnish complete information to the Corporation. In case of delay by the Purchaser in furnishing complete information, or returning accepted contract to the Corporation, the time of shipment shall be reasonably extended, based on the period of Purchaser's delay and conditions at the factory of the Corporation.

7. The Corporation shall not be liable for loss, damage, detention or delay resulting from causes beyond its reasonable control or caused by fire, strike, civil or military authority, priority requests of the United States Government or any department, branch or representative thereof, insurrection or riot, embargoes, car shortages, wrecks or delays in transportation, or inability to obtain necessary labor, materials, or manufacturing facilities due to such causes. Receipt of the apparatus by the Purchaser upon its delivery shall constitute a waiver of all claims for delay.

8. The Purchaser shall not assign this contract or any rights hereunder without written consent of the Corporation. Previous agreement and understandings are superseded by this proposal. No modification hereof shall be binding unless in writing duly accepted by the Purchaser and approved by a duly authorized representative of the Corporation. The Corporation shall not be liable for consequential damages.

9. Prices do not include state or local taxes based on or measured by sales which tax or taxes will be applied to the prices where applicable.

10. The foregoing proposal must be accepted by the purchaser and delivered to the Corporation within fifteen (15) days from its date and must be approved in writing either by an executive officer of the Corporation or by one of its duly authorized managers, in order to make it binding upon the Corporation.

Respectfully yours,

WESTINGHOUSE ELECTRIC CORPORATION

By.....

ACCEPTANCE

The foregoing proposal is hereby accepted at the prices and upon the terms and conditions named therein.

Dated.....19.....

Witness or Secretary

.....
(Purchaser signs here)

.....

.....
(Title)

.....

WESTINGHOUSE ELECTRIC CORPORATION

Approved: At.....19.....
(Insert Place)

By.....

Witness:.....

WESTINGHOUSE FORM 14599P
THREE SHEETS, SHEET 3
Printed in U.S.A.

CORPORATION

State of..... ss.

County of.....

Be it remembered that on this.....day of.....A. D. 19....., before me.....

a Notary Public in and for said County and State, duly commissioned and acting as such, personally appeared.....

President, and.....Secretary of.....the Corporation described in and which executed the above instrument both to me personally known to be the President and Secretary respectively of said corporation, who being by me first duly and severally sworn, did depose, say and acknowledge under oath that they were President and Secretary respectively of said corporation; that being informed of the contents of said instrument, they executed and delivered the same on the day and year therein mentioned as their free and voluntary act and deed, and as the free and voluntary act and deed of said corporation for the uses, consideration and purposes therein expressed; that the signatures of said President and Secretary are in the respective own and proper hand writing of each; that they know the seal of said corporation; that the seal affixed by them is the common or corporate seal of said corporation; and the act of sealing, executing and delivering said instrument was duly authorized by resolution of the directors of said corporation; and I do hereby so certify.

In Witness Whereof I have hereunto set my hand and affixed my official seal the day and year above written.

.....

Notary Public.....

County.....

INDIVIDUAL

State of.....
} SS
County of.....

Be it remembered that on this.....day of.....A. D. 19....., before me.....

a Notary Public in and for said county and state, duly appointed, commissioned and qualified, personally came.....to me well known to be the person who executed the foregoing instrument and declared that he was fully informed as to the contents thereof, and acknowledged that the signing, sealing and delivering of same was his free and voluntary act and deed for the uses, purposes and consideration therein mentioned, and I do hereby so certify.

In Witness Whereof I have hereunto set my hand and affixed my official seal the day and year above written.

.....

Notary Public.....

County.....

F O R E W O R D

WESTINGHOUSE HAS ENJOYED AN ENVIABLE POSITION IN THE RADIO BROADCASTING FIELD EVER SINCE IT BUILT AND OPERATED THE FIRST BROADCASTING STATION - KDKA - in 1920. THE FOLLOWING IS A BRIEF REVIEWOF SOME OF THE WESTINGHOUSE "FIRSTS" IN THE RADIO FIELD.

1. After building the first station KDKA in 1920, it originated the first short wave broadcast in Pittsburgh in 1922.

2. It was the first to use high-power Class "B" audio system in 1931.

3. It was the first to build a remote pick-up station in Pittsburgh - 1924.

4. Westinghouse Stations WBZ and WBZA were the first to operate two broadcasts on the same frequency synchronously in 1926.

5. It was the first to build short wave equipment for ocean going vessels.

6. It was the first to apply for a patent on an electronic beam iconoscope.

7. Westinghouse was the first to install railway radio in 1924 - on the Norfolk and Western Railroad.

8. It was the first to apply for a patent on the cathode ray tube for television.

9. In addition, Westinghouse did much co-development work with other companies, a notable example of which is the design of quartz crystals used in broadcasting transmitters.

EVERY WESTINGHOUSE TRANSMITTER HAS ENGINEERED INTO IT A WEALTH OF EXPERIENCE - FROM THE TECHNICAL RESEARCH ANGLE, AND ALSO FROM THE ACTUAL OPERATING EXPERIENCE POINT OF VIEW.

1. Twenty-four years of building transmitters has contributed much to the Westinghouse storehouse of knowledge in transmitter design.
2. Operating experience gained from the six Westinghouse owned and operated stations - KDKA - WBZ - WOWO - KYW - WBZA - KEX has contributed greatly to the well balanced, highly dependable, easily maintained Westinghouse Transmitters.
3. Our position as one of the main suppliers of Radio and Radar equipment during the war has given the Company a background on Radio and Radar second to none.
4. Many of the men responsible for the design of Westinghouse transmitters have service records as station engineers. Result: A simplified, more easily maintained, and more relia ble transmitter.

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SECTION I

APPLICABLE SPECIFICATIONS

Westinghouse Electric Corporation

This equipment will comply fully with the Federal Communications Commission Rules and Regulations and the Standards of Good Engineering Practice concerning FM Broadcast Stations.

WESTINGHOUSE is a member of the Radio Manufacturing Association and subscribes to its standards. Therefore, the equipment to be supplied will comply with RMA standards in effect as of the date of this proposal. To the extent that it is practical to do so, commensurate with good manufacturing practices, the equipment to be supplied will conform to revised or added RMA standards if these revisions or additions are made known prior to deliveryof the equipment.

SECTION 2

MASTER LIST OF EQUIPMENT

Westinghouse Electric Corporation

ITEM 1: TRANSMITTER

One (1) Westinghouse type FM-10, 10 KW FM Broadcast Transmitter, in accordance with Descriptive Specifications R-1702 and R-1508-A, consisting of the following:

a. Three-cubicle transmitter with duplicate crystal oscillators (one operating and one spare) and one set of instruction books.

b. One set of operating tubes.

c. One complete set of spare tubes.

Net Price - - - - - - - $22,700.00
F.O.B. Lansdowne, Maryland.

Note #1:

The type FM-10 transmitter consists of the type FM-3 transmitter (which serves as a driver) and two matching cubicles which house the 10 KW Power Amplifier and 10 KW Rectifier. A sub-base assembly will be supplied to facilitate mounting the three cubicles for "in-line" installations. As an alternate, the Rectifier Cubicle may be installed remote from the Driver and Power Amplifier; and in such cases appropriate end radii will be supplied in lieu of the sub-base assembly.

Note #2:

If desired, the type FM-3, 3 KW driver unit may be delivered in advance of the 10-KW amplifier Equipment, for interim operation.

Note #3:

Included in the price of the transmitter are the services of an engineer for final tune-up, placing the station on the air and instructing the station personnel in the operation of the transmitter.

ITEM 2: ANTENNA

(a) One (1) RCA Type BF-14-A, Four-section Pylon Antenna, height 54 feet, Power Gain 6.

Net Price - - - - - - - $5,500.00
F.O.B. Brooklyn, N. Y.

(Alternate Antenna)

For installations where a Power Gain of 6 is not required, we offer:

(b) One (1) Western Electric Type 54-A_____Unit, Cloverleaf FM Broadcast Antenna with nominal power gain _____, supplied disassembled for erection by Purchaser; maximum power rating 50-KW, Purchaser to specify assigned frequency.

Price Schedule

Unit	Power Gain	Price (f.o.b. Works)
2	1.30	$1,500.00
3	1.90	1,940.00
4	2.45	2,380.00
5	3.00	2,820.00
6	3.55	3,260.00
7	4.10	3,700.00
8	4.70(92.6-108 MC only)	4,140.00 ✓

(c) Gas tight end terminal for use with Western Electric Type 54-A Antenna; Communications Products Co. Catalog #_____ for connection to _____ O.D. transmission line.

Price Schedule

For O.D. Line	Catalog #	Price (f.o.b. Works)
3-3/8"	46-505	$90.00
6-1/8"	6-506	160.00

ITEM 3: TRANSMISSION LINE

It is recommended that 3-1/8" O.D. or 6-1/8" O.D. 51.5 ohms coaxial cable be used for the R.F. Transmission Line. We propose to furnish Andrew Company line and fittings to satisfy installation requirements. Relative efficiencies of these lines at 100 MC are:

1000 ft. 3-1/8" line, approx. 72%
1000 ft. 6-1/8" line, approx. 88%

This line is supplied in 20-ft. lengths, with solderless, flange-type connectors. Price per 20-ft. length is approx. $77.00 for 3-1/8" and approx. $240.00 for 6-1/8". Fittings and accessories are additional.

ITEM 4: TRANSMITTER AUDIO EQUIPMENT

Descriptive specification R-1851 included as a part of this proposal describes various groups of Audio Frequency Input Equipment and Monitorin Equipment which can be supplied. Variations from these standard groups are also available. Prices will be furnished for any group or combination of groups desired.

ITEM # 5: TRANSMITTER CONSOLE

One (1) Westinghouse Standard Transmitter Console for use with Item #1, in accordance with Descriptive Specification R-1766-C, consisting of desk, operating console and chair.

Net Price - - - - - - - $1,625.00 ✓
F.O.B. Lansdowne, Md.

ITEM 6: STUDIO EQUIPMENT

Studio Equipment will be furnished to meet the requirements of each individual installation. Descriptive Specifications R-1775 and R-1832 are included in this proposal and will suggest a number of possible arrangements, using both the RCA 76-B-2 Consolette and the W.E. Type 23-B Speech Input Equipment. Prices will be furnished on any of the standard combinations desired.

SECTION 3

DESCRIPTIVE SPECIFICATIONS

Type FM-3 Transmitter - - - - - - - -	R-1702
Type FM-10 Transmitter - - - - - - -	R-1508-A
Type 54-A Cloverleaf Antenna- - - -	WECO-T-2220-B
Transmitter Audio Equipment - - - -	R-1851
Transmitter Console - - - - - - - - -	R-1766-C
Studio Audio Frequency Equip. - - - -	(R-1775
	(R-1831

Descriptive Specification

WESTINGHOUSE

FM-3

3KW FREQUENCY MODULATED BROADCAST TRANSMITTER

WESTINGHOUSE ELECTRIC CORPORATION
Industrial Electronics Division — Baltimore, Maryland

January 20, 1946 — *R-1702*

DESCRIPTIVE SPECIFICATION

WESTINGHOUSE FM-3

3 KILOWATT FM BROADCAST TRANSMITTER

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List of Photographs and Drawings

NOTE: The photographs listed are of the Type FM-1, 1KW, Transmitter. Final photographs of the Type FM-3, 3KW, Transmitter are not available at the present time. However, these photographs are representative of the FM-3 transmitter. The cubicle used is exactly the same in both cases and the arrangement of the equipment is essentially the same.

I. GENERAL INTRODUCTION

The new Westinghouse 3KW Frequency Modulated Broadcast Transmitter was designed from the start for the specified output frequencies and is no adaptation of a previous model operating at other frequencies. The advanced circuit developments incorporated in this transmitter result in exceptional performance characteristics, reliability of operation, and simplicity of adjustment. There have been no compromises with low frequency techniques.

The new electrical design is supplemented by a sound mechanical design which provides ready accessibility of all apparatus, rugged construction, and distinctive appearance.

The following outstanding features of the transmitter are typical of the advantages offered:

1. Direct generation of the modulated carrier by a simple and straight-forward circuit.
2. Crystal-derived center-frequency stabilization independent of circuit tuning.
3. Extremely conservative ratings on all power transformers.
4. Complete fuseless overload protection.
5. Supervisory control.
6. Lead covered wire used for all cubicle wiring where appropriate.
7. Conservative operation of tubes and components.
8. Low operating cost.
9. Ease of maintenance.
10. May be easily adapted for higher power by adding a 10 kw. amplifier unit.
11. None but the finest quality components used.

II. ELECTRICAL SPECIFICATIONS

Carrier power output	3,000 watts
Carrier frequency *(single specified frequency)*	88 to 108 mc/s
Frequency stability	Better than ±1,000 cps.

Output line impedance	51.5 ohm line in accordance with RMA standards.
Modulation Capability	±100 kc/s
Audio frequency response *(30 to 15,000 cycles)*	Without pre-emphasis, ±1 db from response at 1,000 cycles; with pre-emphasis, ±1 db from 75 microsecond curve.
Audio input for ±75 kc/s carrier swing	+10 dbm at 400 cycles
Audio input impedance	600/150 ohms
Harmonic distortion *(including all harmonics up to 30 kc/s at ±75 kc/s swing)*	Less than 1.5% rms for modulating frequencies between 50 and 15,000 cps
FM noise level	At least 65 db below ±75 kc/s swing
AM noise level	At least 50 db below 100%AM
Power supply	208-240 volts, 50 or 60 cycles, 3 phase; 115 volts, 50/60 cycles, single phase for crystal heaters
Power input	8,500 watts at 90% power factor.

III. TUBE COMPLEMENT

MO Frequency Modulated Oscillator	
Audio amplifier	1 type 6SJ7
Modulator control	1 type 1614
Modulator	1 type 6H6
Feedback discriminator	1 type 6H6
FM oscillator/tripler	1 type 1614
Tripler	1 type 829B
Intermediate amplifier	1 type 829B
MP Frequency Stabilizer	
Buffer amplifier	1 type 6SJ7
#1 crystal oscillator	1 type 1614

#2 crystal oscillator	1 type 1614
#1 mixer	1 type 6SA7
#2 mixer	1 type 6SA7
Amplifier	1 type 6SN7
Pulse generator	1 type 6SN7
Pulse discriminator	1 type 6H6
Pulse amplifier/limiter	1 type 6SL7
Pulse limiter	1 type 6H6
Balanced pulse counter	2 type 6H6
Cathode follower	1 type 6SL7
Voltage regulator	1 type 0D3/VR150 1 type 0C3/VR105
Bias rectifier	1 type 6X5
Bias regulator	1 type 0C3/VR105
Low voltage Regulator	
Regulator	2 type 6Y6G
Regulator control	1 type 6SJ7
Control bias	1 type 0C3/VR105
Low voltage rectifier	2 type 866A
High voltage rectifier	6 type 872A
Driver	2 type 4-250A
Power amplifier	2 type WL-473
RF voltmeter rectifier	1 type 9006

IV. MECHANICAL SPECIFICATIONS

The complete transmitter is enclosed in a heavy guage sheet aluminum cubicle which is attractively styled and finished in harmonious blue-gray and gray. The external hardware such as door handles is satin chrome plated. All doors which permit access to parts at dangerous potentials are interlocked. The front and rear door interlocks remove all voltages above 230 from the cubicle and ground the output of the high voltage supply. The front doors which cover compartments containing tuning or control adjustments are not interlocked, as all controls are at ground potential. Glass panels in the rear doors permit inspection of the inside of the transmitter while it is in operation. The driver tubes and the power amplifier tubes are visible through the upper front glass door while they are in operation. The high voltage rectifier tubes are likewise visible through the lower front glass door.

V. MECHANICAL DATA

Cubicle overall dimensions	66" wide, 34" deep, 74" high
Clearance for opening doors	26" on front and 32" on rear
Weight of cubicle	Approximately 1,900 lbs.

VI. GENERAL DESCRIPTION

The transmitter is completely contained in its cubicle, the only external connections being the 208-240 volt, 3 phase, power input, the 115 volt a.c. power input for crystal heaters and the convenience outlet, the program input line, the r.f. output line for connecting the modulation monitor and frequency meter, and the co-axial line to the radiating system. The type MO Modulated Oscillator Unit and the Type MP Frequency Stabilizer Unit contain the exciter and frequency stabilizing circuits. These units are of the plug-in type and may be easily removed from the cubicle. All of the other transmitter circuits are wired into the cubicle in such a manner that all portions are readily accessible.

VII. TYPE MO FREQUENCY MODULATED OSCILLATOR

This plug-in unit is located behind the lower left front door and may be removed by loosening four thumb-screws and sliding it from the cubicle by means of the pull handles attached. All electrical connections to the unit including co-axial lines are made by means of a plug at the rear of the unit. Access may be had to the unit without removing it from the cubicle. This is done by opening the cubicle rear doors, loosening two captive thumb-screws, and removing the protective dust cover from the rear of the unit. The modulated oscillator and modulator circuits are protected from extraneous vibrations and jarring by being completely shockmounted. The tuning knobs on the front panel are vernier controls which are used in tuning the unit once it has been adjusted for the assigned frequency. The switch on the front panel is for inserting or removing the pre-emphasis circuit. The two meters indicate the tuning of the feedback discriminator, the other meters for the modulator, oscillator and amplifier circuits being grouped with other meters of similar importance on the cubicle control panel. The circuits contained in this unit include the following.

a. Audio amplifier

b. Modulator control

c. Modulator

d. Oscillator/tripler

e. Feedback discriminator

f. Tripler

g. Intermediate amplifier

A type 1614 tube is used in the electron-coupled oscillator which triples the frequency in its plate circuit. The second r.f. stage, using a type 829 tube, is a push-pull tripler, which is followed by a push-pull intermediate amplifier stage using another type 829 tube from which excitation is taken from the unit to the driver. An inverse feed-back loop around the oscillator,

audio amplifier and modulator is accomplished by means of the feedback discriminator using a type 6H6 tube. The modulator is of the diode type which has more freedom from noise effects than the conventional reactance tube modulator. In this circuit a type 6H6 tube as modulator is controlled by a type 1614 tube which has the modulating signal impressed on its grid. The audio amplifier consists of a type 6SJ7 tube in a resistance-coupled circuit.

The r.f. amplifier circuits are designed so that short and symmetrical interconnections obtain and yet all components are easily accessible. All tubes are readily replaceable.

The plate power for the audio amplifier, modulator and oscillator/tripler is obtained from an electronically regulated supply. All circuits are shielded to prevent undesired coupling and radiation.

The modulated oscillator is operated at one-ninth of the assigned frequency of the transmitter. It has been found that simple tuned circuits in the multiplier stages provide adequate selectivity without cutting the side bands when the modulation is applied in this region. If frequencies very much lower were used, special band pass filters would have to be employed to provide the band width and selectivity at the same time.

VIII. TYPE MP FREQUENCY STABILIZER

This unit is likewise plug-in and is located behind the lower right front door. It is removable in the same manner as the Type MO Frequency Modulated Oscillator and is also accessible from the rear of the cubicle by loosening two captive thumb-screws and removing the dust cover from the unit.

This unit also contains the two plug-in crystal oscillator units, either of which may be selected by a switch on the front panel of the Frequency Stabilizer Unit.

Each crystal is mounted in one of the newly developed Bliley TC92 plug-in units which contains a thermostat supplied by Westinghouse. This unit will maintain crystal temperature within $\pm 1^{\circ}C$. at any ambient temperature between minus $20^{\circ}C$. and plus $65^{\circ}C$. The frequency stability of the unit is in the order of $\pm$ .0005% or better after the oven has reached operating temperature. The crystal heaters operate from 115 volts a.c. and are connected so that continuous thermostatically controlled operation may be maintained.

The crystal oscillator employs a type 1614 tube in an electron coupled circuit and is conservatively operated at low voltage. Output is taken from the plate circuit of the oscillator at twice the crystal frequency. It may be noted that the fundamental crystal frequency is one-eighteenth of the assigned operating frequency, and that output from the crystal oscillator is at the center frequency of the modulated oscillator which is one-ninth of the assigned frequency. The crystal oscillator output is fed through two 45 degree phase shift networks, each consisting of one resistor and one capacitor. One of these networks shifts the phase forward by 45 degrees and the other retards the phase by the same

amount. R.f. voltage from the modulated oscillator is introduced into the Frequency Stabilizer unit through a fixed-tuned buffer amplifier stage employing a type 6SJ7 tube. The output of this stage is mixed with the quadrature voltages from the phase shift networks in two type 6SA7 mixer tubes. The output of one mixer tube after being amplified through one-half of a type 6SN7 is used to trigger a type 6SN7 direct coupled multivibrator. This multivibrator serves as an electronic switch to make square waves from the sine wave input from the mixer. Since the input to the multivibrator is much greater than the amount required to trigger it, the time at which the multivibrator turns over will be approximately the time at which the voltage of the output of its exciting mixer passes through zero. At this time the output of the other mixer is at either a positive or negative peak.

The voltage on each of the two multivibrator plates is differentiated by a series capacitor and shunt resistor. The resultant two voltages appear as a series of pulses of opposite polarity. These two pulse outputs are introduced into the two halves of a type 6H6 pulse discriminator. Also introduced into this pulse discriminator is the output of the second mixer through one-half of an intervening type 6SN7 amplifier. The bias on the pulse discriminator is set just above the peak value of the amplified output of the second mixer. The result is that when the pulses add to the sine wave, the bias is overcome and the pulse is passed through the diode. When the pulse subtracts from the sine wave, the bias prevents the diodes from conducting and the pulse is not passed. This arrangement serves to separate the pulses into two circuits. One circuit is energized by one pulse for each cycle of beat when the signal frequency is high, and the other circuit is energized by one pulse for each cycle of beat when the signal frequency is low.

Each output of the pulse discriminator is fed into one section of a type 6SL7 pulse amplifier/limiter, the output of which is controlled by an additional 6H6 pulse limiter. From this point the two pulse outputs are fed into two type 6H6 pulse counters arranged in a balanced circuit to control the charge in a storage capacitor. The voltage across the storage capacitor is applied to the two grids of a type 6SL7 dual cathode follower, one section of which controls the bias on the FM modulator tube in the Frequency Modulated Oscillator unit previously described. Since the modulator tube controls the frequency of the modulated oscillator, the frequency is a direct function of the charge on the storage capacitor. There is no bleeder resistor across this storage capacitor, hence the system has no natural frequency which the frequency control must overcome.

If the average frequency of the modulated oscillator is different from the reference frequency, the charge on the storage capacitor is continually changed in the direction to overcome the difference. When the difference has been overcome, the system becomes balanced, and the only tendency to pull off is due to stray leakages which cause negligible frequency drift.

There are a number of advantages offered by this circuit, perhaps the most important of which is the lack of tuned circuits and critical components. The frequency controlling circuits by themselves contain no tuned circuits, frequency dividers, or locked oscillators. No test instruments are needed to place these circuits in operation. Another important advantage is that tube characteristics are not important. Since each tube in the circuit is driven from grid current to cut-off, merely acting as an electronic switch, the actual condition of the tubes becomes relatively unim-

portant. Long before any tube would become inoperative in the circuit, it would be discarded because of routine tube checks.

The controls on the front panel of the Frequency Stabilizer Unit are the crystal oscillator selector switch and the frequency control off-on switch *(which enables the disconnection of the frequency correction voltage.)* One meter indicates mixer grid current and thus shows input to the unit from the modulated oscillator, the other meter indicating the cathode current of the crystal oscillator in use. The indicating lamp shows when the frequency control switch is in the "on" position.

IX. CUBICLE CIRCUITS

Access to the tubes in the electronic voltage regulator for the modulated oscillator power supply may be had by opening the top front glass door. These tubes are located on the left end of the upper shelf. This regulator furnishes well-regulated plate voltage with extremely low ripple content for the modulated oscillator and modulator.

In the adjacent compartment on the upper shelf are mounted the two 4-250A driver tubes. The driver grid circuit components are located underneath the shelf where short and direct interconnections obtain. The trough-line plate tank for the driver stage is located directly above the driver tubes. This tank circuit is arranged in such a manner that no blocking capacitors are used in the shunt-fed plate circuit. Both the grid and plate tank circuits of the driver are motor tuned, with the controls mounted on the main control panel. The manual control for tuning the driver screen grid is located on the driver grid assembly located behind the control panel. The correct adjustment of this capacitor is easily accomplished by tilting the hinge control panel forward. After adjusting this condenser the control is locked in place as no further adjustment of this capacitor is necessary.

To the right of the driver tubes are located the two WL473 power amplifier tubes with their grid series-tuning capacitors. The controls for adjusting the two power amplifier grid series-tuning capacitors are located on each side of the forward end of the PA Tank Line. As in the case of the driver screen grid tuning control these controls are accessible by tilting the hinge control panel forward. After being properly adjusted these controls are locked in place as further adjustment of this tuning control is necessary. The adjustment of these grid series-tuning capacitors is simple and has none of the complexity of conventional neutralizing adjustments. Since the grounded-grid circuit is used in the power amplifier stage, excitation is applied to the cathode lines of the power amplifier which are located just above the power amplifier tubes. The anode of each tube fits down into the end of its anode line which is arranged so as to use no blocking capacitor. The anode line tuning and output coupling are both motor driven, with controls being located on the main control panel.

A flexible co-axial line connects from the variable output coupling arrangement to the r.f. transmission-line voltmeter capacity-divider and meter rectifier unit. The other end of this unit has provision for mounting an

appropriate end-seal and terminating the transmission line to the radiating system. One type 9006 tube is used as the voltmeter rectifier.

Cooling air intake is through the protected round ports in the rear of the base. From these ports, air passes up through the bottom of the cubicle, through a filter box, around the high voltage transformers, and into the blower. From the blower, air passes through a duct to the plenum chamber from whence it flows through the anode fins of the two WL473 tubes and also over the seals of the two driver tubes. Air is exhausted through a screened port in the top of the cubicle.

Overload and under-voltage protection is supplied in all circuits where necessary.

The supervisory control system consists of a series of relays and indicator lamps so connected that the operation of any overload relay operates a corresponding supervisory relay which locks itself in, lighting the corresponding indicator lamp. This indication remains on the control panel until reset by the operator. This system enables the operator to tell at a glance in which circuit the overload occurred, even though the transmitter has returned to the air. This is particularly useful in checking for the possible cause of the outage.

Thorough protective interlocking is used with dependable relays, switches and contactors. The control system is interlocked so that it is impossible to apply power in the wrong sequence. Sufficient indicators are provided so that proper sequence can be easily followed.

All main power switches are of the De-ion type with thermal-overload release. This gives full protection of the power circuits without the use of fuses. A positive indication is given when tripped by overload in that the switch handle assumes a position in the middle of the slot. This protection is in addition to the protection given by the numerous overload relays employed throughout the major circuits of the equipment.

The filament, low-voltage and high-voltage rectifiers may be controlled from a remote point. Provision is also made for indicator lamps at the remote point.

The main control panel is located behind the folding drop-leaf door on the front of the cubicle. When opened, this door provides a convenient arm rest for the operator and is useful for supporting writing pads or logs while entering meter readings.

The indicators at the left of the control panel are the supervisory overload and under voltage indicators, with the supervisory indicator reset switch located below them. To the right of these indicators are the driver grid tuning indicator and control, the driver plate tuning indicator and control, and the 3KW AMP plate tuning indicator and control. The central group of meters indicate plate and grid currents of the tubes in the Type MO Modulated Oscillator Unit mounted below. Below these meters are the crystal power "on" indicator and the two crystal heater indicators. On the right of this group of meters and indicators are the transmission line coupling indicator and control, and the bus phase voltmeter and switch for inserting the voltmeter

across any of the three phases. Adjacent to the voltmeter on the right is the 230 v. bus regulator control, and below this control are the air indicator and the high voltage regulator control. In the group of nine indicators and switches at the right of the control panel are the filament power switch and "ready" and "on" indicators, the 400 volt switch and "ready" and "on" indicators, and the high voltage switch and "ready" and "on" indicators.

The wide-scale, easily read meters at the top of the cubicle indicate, reading from left to right, driver grid current, driver plate current, power amplifier grid current, power amplifier plate current, high voltage, and transmission line voltage. These meters have 270^{o} scales and are illuminated for optimum readability by means of fluorescent lights in the trough below and immediately in front of the meters.

The high voltage and low voltage rectifier tubes may be seen through the lower front glass door, through which they may be quickly replaced in the event of tube failure. On the upper shelf, in the compartment to the right of the power amplifier tube are receptacles for storing spare rectifier, driver and power amplifier tubes.

Motor driven line voltage regulators are used on both the auxiliary bus and the high voltage supply. By means of the regulator in the high voltage supply, the output power may be reduced from rated power to one kilowatt. The filter capacitors in both high and low voltage supplies are made up by paralleling low capacity units. In the event of failure of one section, it may be cut out of the circuit and operation continued. Also, the cost of replacing a single unit is considerably less.

All appropriate cubicle wiring is done with high grade lead-covered wire. This results in a neat and clean wiring job. Further advantages are freedom from cross-talk and extraneous pick-up.

Long-lived Class B *(mica and glass)* insulation is used in all power transformers and reactors, however, all of these components are operated under low-temperature-rise, Class A conditions so that the maximum possible service life is to be expected.

X. INSTRUCTION BOOKS

Each equipment will be supplied with two copies of the instruction book for the Westinghouse FM-3 Transmitter. This instruction book will contain complete adjustment and operation information in sufficient detail to assure correct procedure by reasonably skilled operating personnel. It will be complete with schematic diagrams. The information furnished will be in sufficient detail to be readily usable in installation, servicing and maintenance.

A complete list of electrical parts with ordering information will be included to simplify replacement of electrical parts, or expendable items or parts thereof.

A list of recommended spare parts will be supplied which should cover ordinary service requirements for two years.

XI. IMPROVEMENTS

In the construction of the equipment described in this specification, the full intent of the specification will be carried out. However, it is assumed that any minor changes which may be found desirable later for reasons of improved design or construction will be accepted.

The Westinghouse Electric Corporation reserves the right to make changes in design or to make additions to or improvements in its products without imposing any obligation upon itself to install them on its products previously manufactured.

XII. SAMPLE CONSTRUCTION PERMIT

As an aid in preparing FCC Form Number 319, there are attached sample pages 27 and 28 from this form.

TECHNICAL INFORMATION

Description of transmitting apparatus proposed to be installed:

(a) Make *Westinghouse Electric Corp.* Type No. *FM-3*

(b) Oscillator: Type of Circuit *Colpitts* Number, make and type of tubes *One RCA type 1614 in electron-coupled Colpitts circuit.*

(c) List buffer and intermediate power amplifier stages, by number and type of tubes in each stage *One RCA 829 tripler, one RCA 829 intermediate amplifier, Two Eimac 4-125 driver amplifier.*

(d) Last radio stage: Number, make and type of tubes *Two Westinghouse WL473*

(e) Modulator or last audio stage: Number, make and type of tubes and how modulation is obtained *One RCA 1614 and one RCA 6H6. Resistance-capacity frequency modulation of oscillator.*

(f) The transmitter is designed for what maximum swing *±100* kilocycles

(g) State make and type number of modulation monitor *To be specified by applicant*

(h) Specify make, type number, and full-scale reading of the following meters:

(1) In last radio stage:
Plate voltmeter *Westinghouse Type KX-24 0-3000 V.D.C.*
Plate ammeter *Westinghouse Type KX-24 0-3 Amps.*

(2) Antenna or transmission line meter *Westinghouse Type KX-24 0-500 Volts R.F.*

(i) Maximum rated power output of transmitter is *3000* watts

(j) Give the following overall characteristics of the transmitter:

(1) Frequency characteristic: uniform within 1 decibels of 1000 cycle level within the range from 30 to 15000 cycles. without pre-emphasis.

(2) Amplitude characteristics: Distortion 1.5 percent RMS harmonics within the range from 50 to 15000 cycles. 1% harmonics from 100 to 7500 cycles.

(3) Noise level (Frequency modulation) 65 decibels below 100 percent modulation (30 to 15000 cycles).

(4) Noise level (amplitude modulation) 50 decibels below 100 percent modulation (30 to 15000 cycles).

(5) Will a pre-emphasis circuit be used in the transmitter by which the higher frequencies will be emphasized in accordance with the impedance-frequency characteristics of a series inductance-resistance circuit having a time constant of 100 microseconds *Yes* The frequency characteristics of the transmitter with the pre-emphasis circuit will be within 1 decibel of the calculated characteristics of such circuit.

Description of automatic frequency control equipment:

(a) Make *Westinghouse Electric Corp.* Type No. *MP*

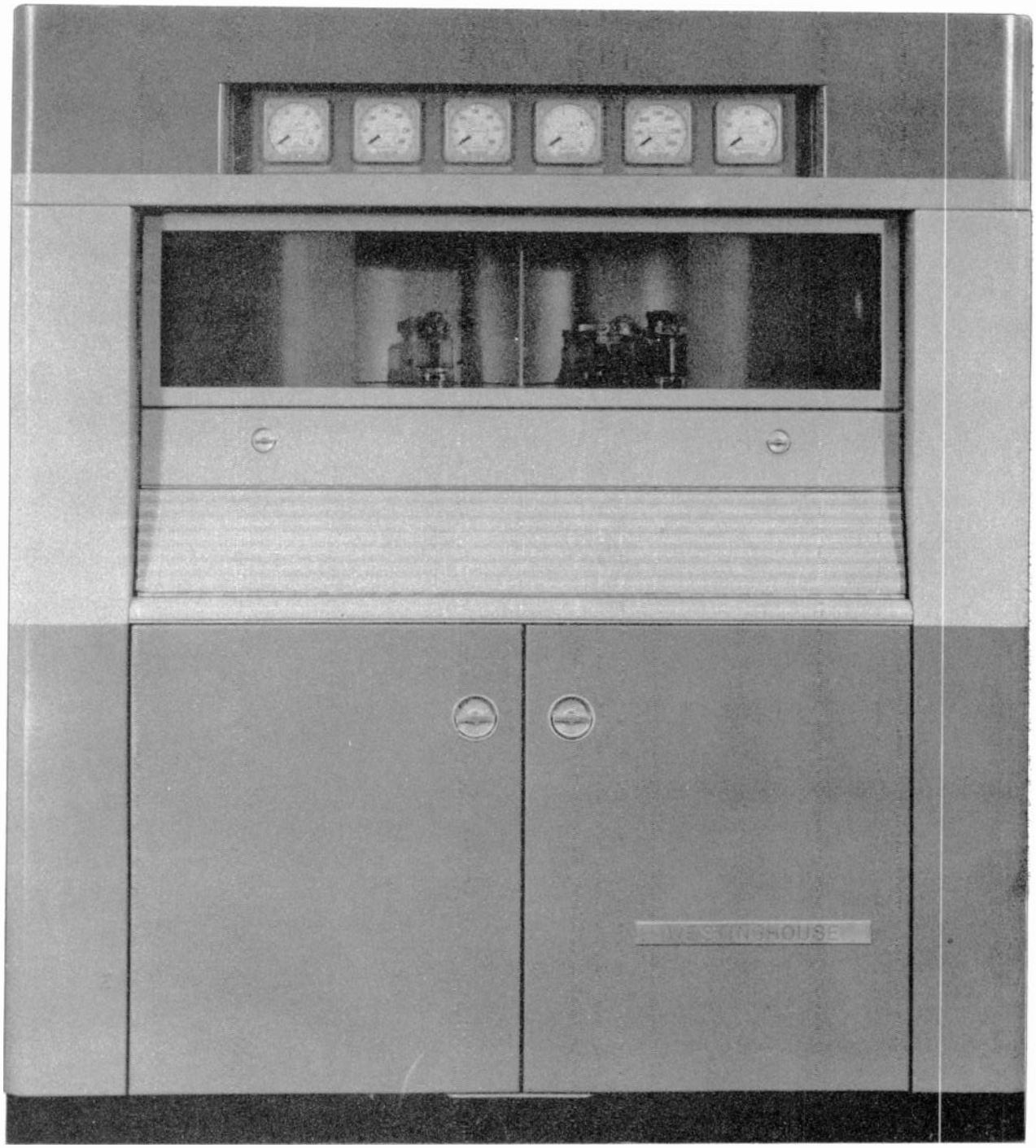
(b) Give make, type of cut and temperature coefficient in cycles per degree centigrade if quartz crystal used *Bliley Type TC-92, Type BT-low temp. coefficient 1 cycle/Mc/°C.*

(c) By whom will unit be calibrated? *Westinghouse Electric Corp.*
Calibrated Frequency: * kilocycles at _____ degrees centigrade.
**To be specified by applicant, determined by assigned freq.*

(d) State number of frequency control oscillators which will be maintained constantly at correct operating temperature and frequency in heat-controlled chambers *Two*

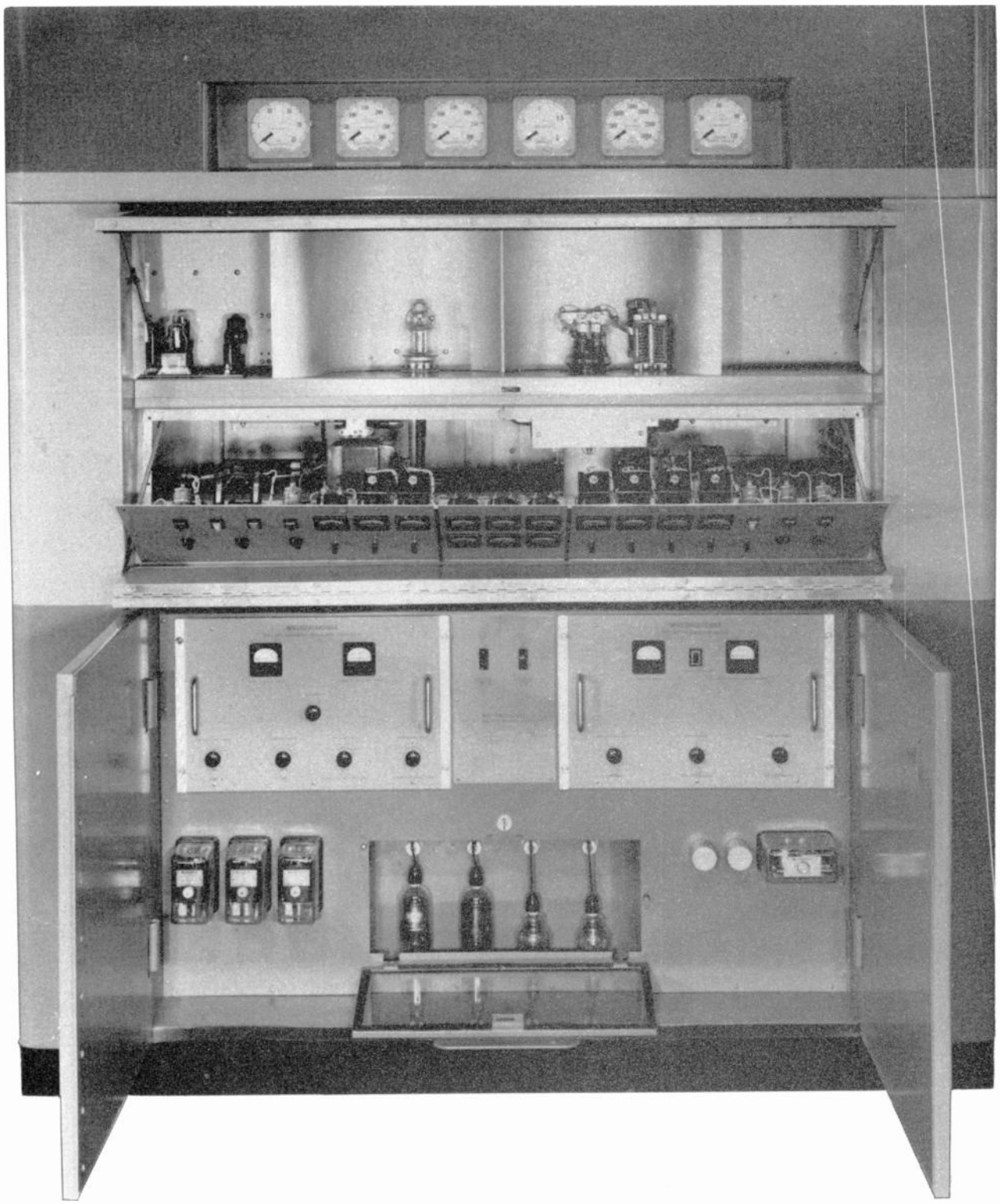
(e) Is provision made for instantaneous connection of spare frequency control units? *Yes*

(f) State make and type number of separate frequency monitor *to be specified by applicant.*

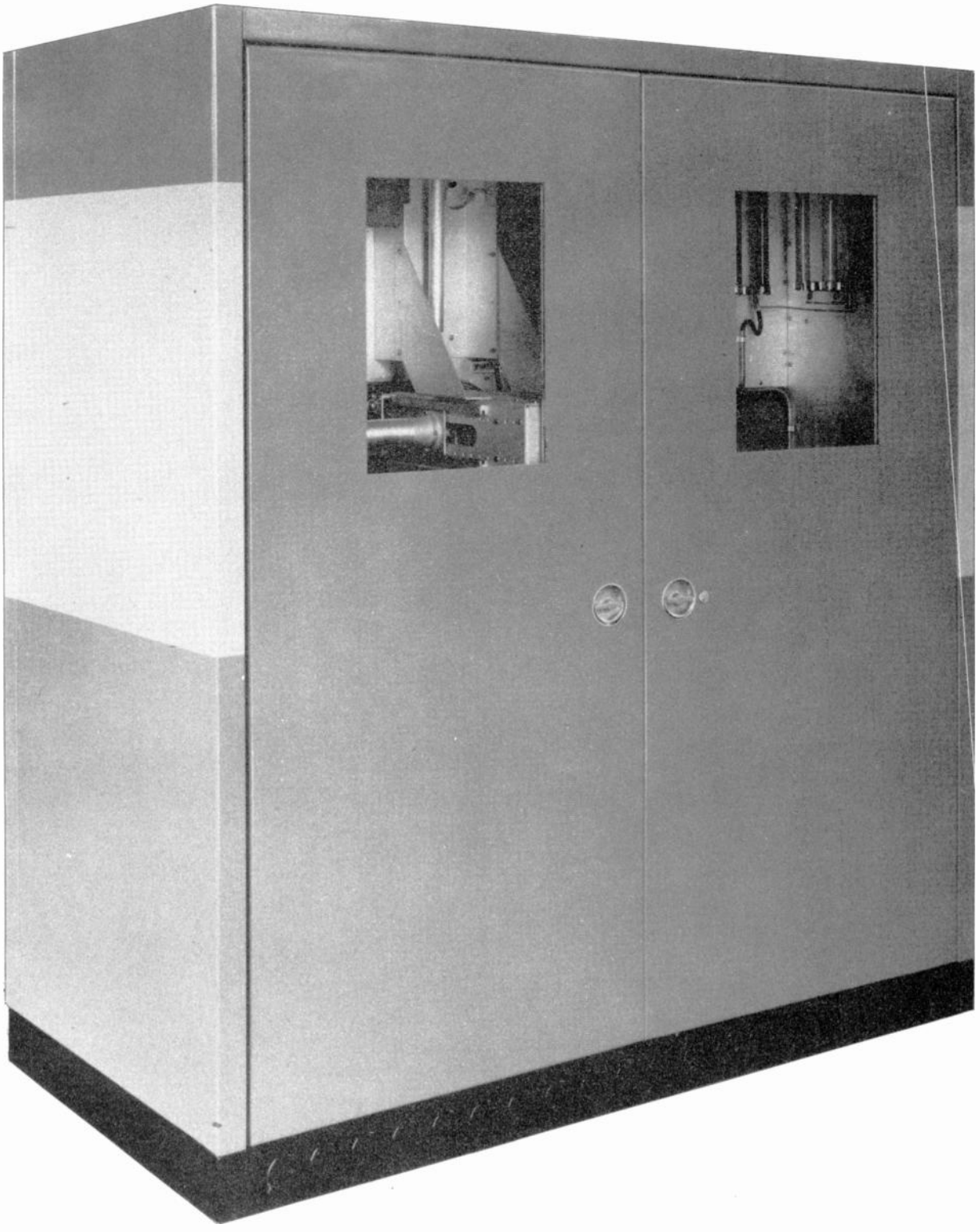


TRANSMITTER, FRONT VIEW
(Photo C-9730)

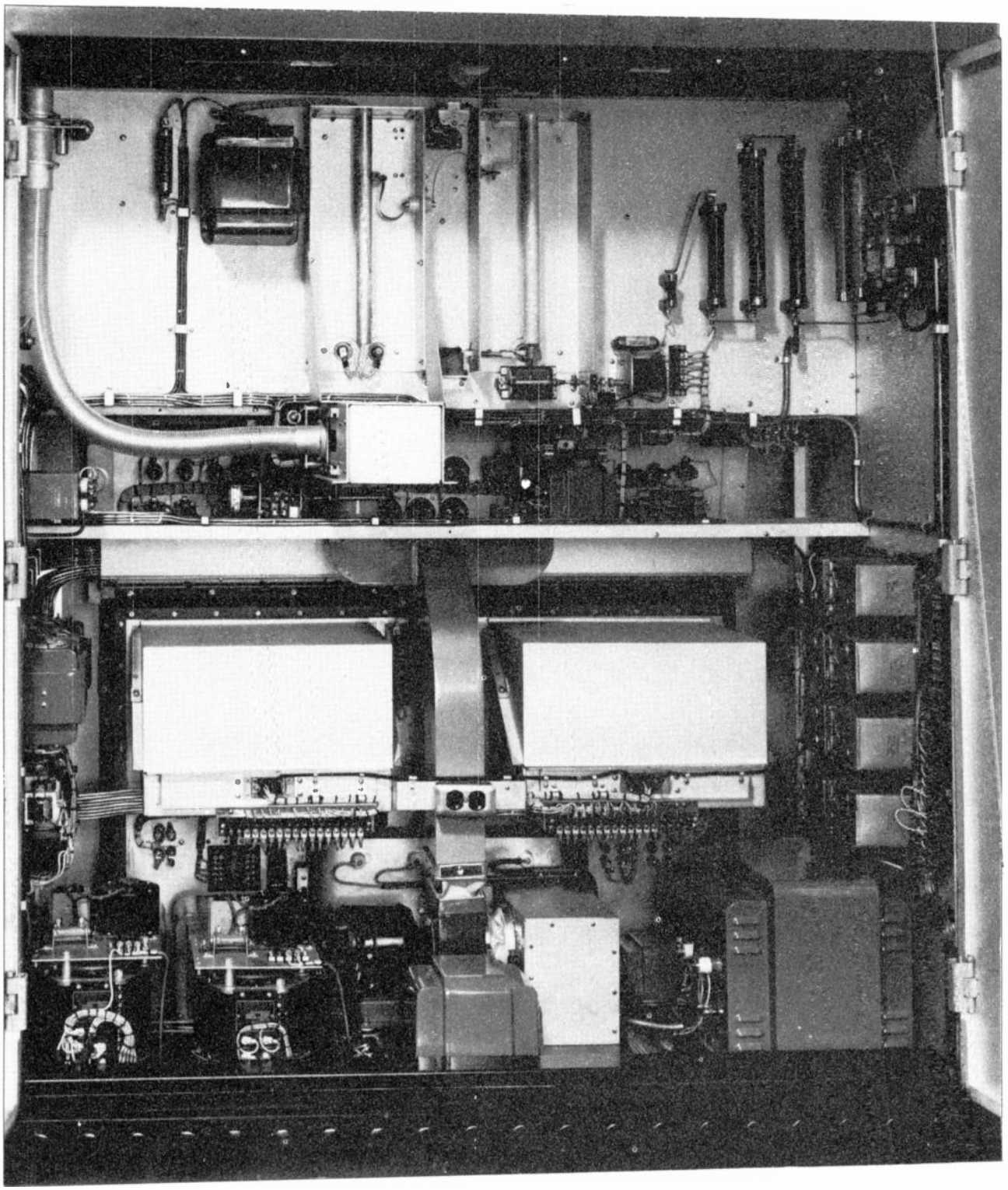
TRANSMITTER, FRONT PERSPECTIVE VIEW
(Photo C-9729)



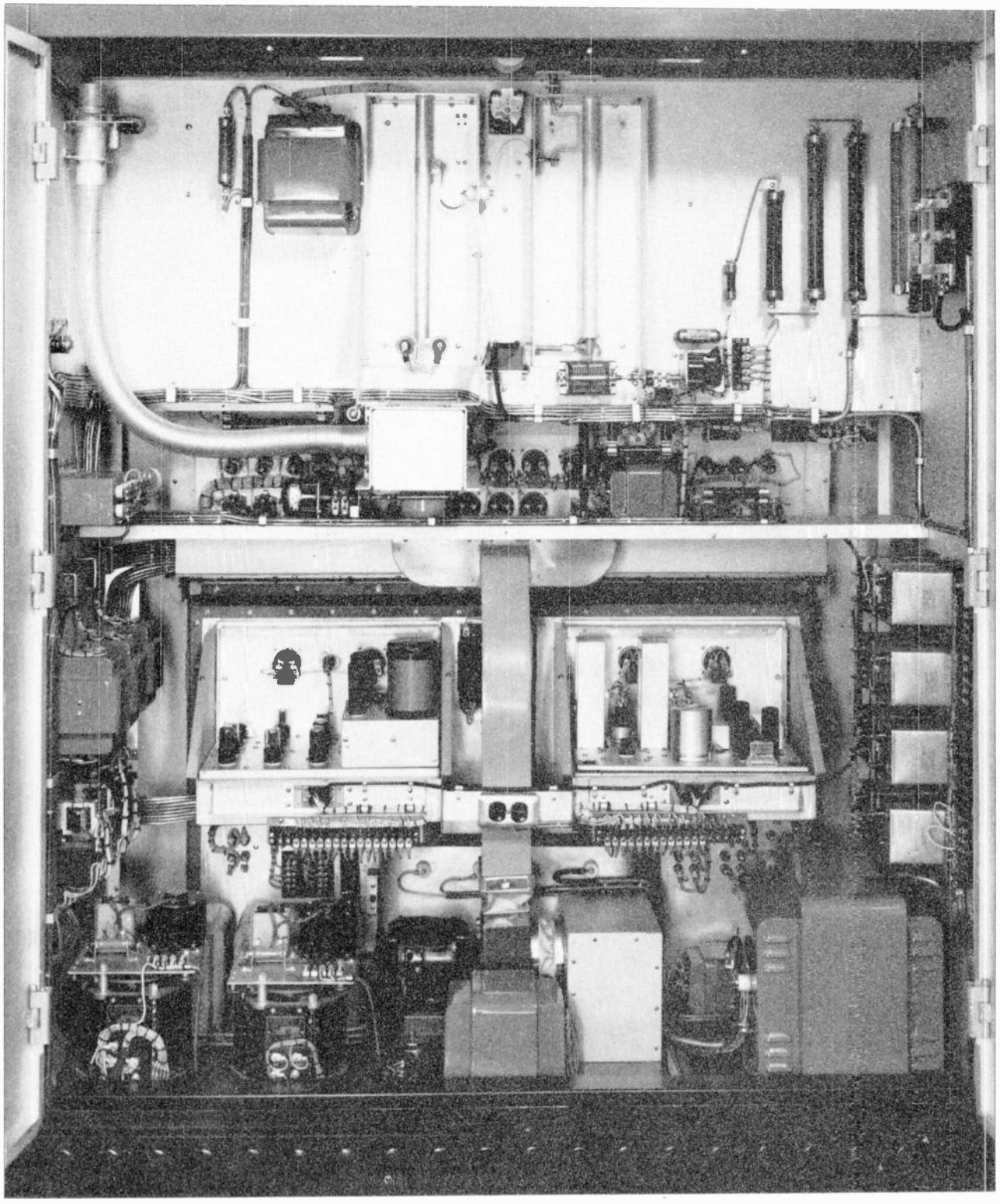
TRANSMITTER, FRONT VIEW WITH ALL DOORS OPEN
(Photo C-9726)



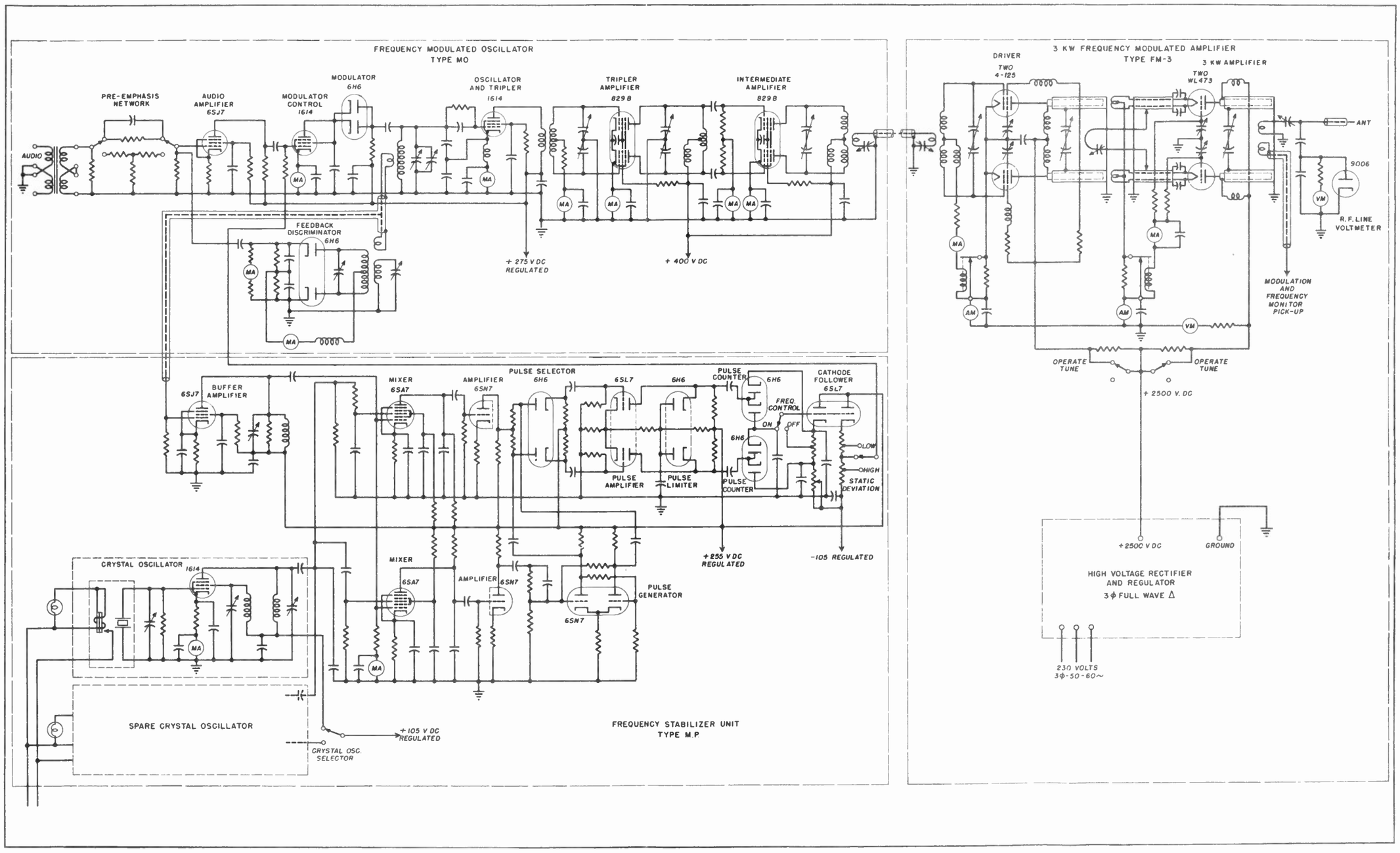
TRANSMITTER, REAR PERSPECTIVE VIEW
(Photo C-9728)



TRANSMITTER, REAR VIEW WITH DOORS OPEN
(Photo C-9723)



TRANSMITTER, REAR VIEW WITH DOORS OPEN AND
UNIT DUST COVERS REMOVED
(Photo C-9731)



SCHEMATIC DIAGRAM, 3 KW FM TRANSMITTER
(Dwg. 7616779)

DESCRIPTIVE SPECIFICATION

WESTINGHOUSE FM-3

3 KILOWATT FM BROADCAST TRANSMITTER

INDEX

List of Photographs and Drawings

NOTE: The photographs listed are of the Type FM-1, 1KW, Transmitter. Final photographs of the Type FM-3, 3KW, Transmitter are not available at the present time. However, these photographs are representative of the FM-3 transmitter. The cubicle used is exactly the same in both cases and the arrangement of the equipment is essentially the same.

I. GENERAL INTRODUCTION

The new Westinghouse 3KW Frequency Modulated Broadcast Transmitter was designed from the start for the specified output frequencies and is no adaptation of a previous model operating at other frequencies. The advanced circuit developments incorporated in this transmitter result in exceptional performance characteristics, reliability of operation, and simplicity of adjustment. There have been no compromises with low frequency techniques.

The new electrical design is supplemented by a sound mechanical design which provides ready accessibility of all apparatus, rugged construction, and distinctive appearance.

The following outstanding features of the transmitter are typical of the advantages offered:

1. Direct generation of the modulated carrier by a simple and straight-forward circuit.
2. Crystal-derived center-frequency stabilization independent of circuit tuning.
3. Extremely conservative ratings on all power transformers.
4. Complete fuseless overload protection.
5. Supervisory control.
6. Lead covered wire used for all cubicle wiring where appropriate.
7. Conservative operation of tubes and components.
8. Low operating cost.
9. Ease of maintenance.
10. May be easily adapted for higher power by adding a 10 kw. amplifier unit.
11. None but the finest quality components used.

II. ELECTRICAL SPECIFICATIONS

Carrier power output	3,000 watts
Carrier frequency *(single specified frequency)*	88 to 108 mc/s
Frequency stability	Better than ±1,000 cps.

Output line impedance	51.5 ohm line in accordance with RMA standards.
Modulation Capability	±100 kc/s
Audio frequency response *(30 to 15,000 cycles)*	Without pre-emphasis, ±1 db from response at 1,000 cycles; with pre-emphasis, ±1 db from 75 microsecond curve.
Audio input for ±75 kc/s carrier swing	+10 dbm at 400 cycles
Audio input impedance	600/150 ohms
Harmonic distortion *(including all harmonics up to 30 kc/s at ±75 kc/s swing)*	Less than 1.5% rms for modulating frequencies between 50 and 15,000 cps
FM noise level	At least 65 db below ±75 kc/s swing
AM noise level	At least 50 db below 100%AM
Power supply	208-240 volts, 50 or 60 cycles, 3 phase; 115 volts, 50/60 cycles, single phase for crystal heaters
Power input	8,500 watts at 90% power factor.

III. TUBE COMPLEMENT

MO Frequency Modulated Oscillator	
Audio amplifier	1 type 6SJ7
Modulator control	1 type 1614
Modulator	1 type 6H6
Feedback discriminator	1 type 6H6
FM oscillator/tripler	1 type 1614
Tripler	1 type 829B
Intermediate amplifier	1 type 829B
MP Frequency Stabilizer	
Buffer amplifier	1 type 6SJ7
#1 crystal oscillator	1 type 1614

#2 crystal oscillator	1 type 1614
#1 mixer	1 type 6SA7
#2 mixer	1 type 6SA7
Amplifier	1 type 6SN7
Pulse generator	1 type 6SN7
Pulse discriminator	1 type 6H6
Pulse amplifier/limiter	1 type 6SL7
Pulse limiter	1 type 6H6
Balanced pulse counter	2 type 6H6
Cathode follower	1 type 6SL7
Voltage regulator	1 type 0D3/VR150 1 type 0C3/VR105
Bias rectifier	1 type 6X5
Bias regulator	1 type 0C3/VR105
Low voltage Regulator	
Regulator	2 type 6Y6G
Regulator control	1 type 6SJ7
Control bias	1 type 0C3/VR105
Low voltage rectifier	2 type 866A
High voltage rectifier	6 type 872A
Driver	2 type 4-250A
Power amplifier	2 type WL-473
RF voltmeter rectifier	1 type 9006

IV. MECHANICAL SPECIFICATIONS

The complete transmitter is enclosed in a heavy guage sheet aluminum cubicle which is attractively styled and finished in harmonious blue-gray and gray. The external hardware such as door handles is satin chrome plated. All doors which permit access to parts at dangerous potentials are interlocked. The front and rear door interlocks remove all voltages above 230 from the cubicle and ground the output of the high voltage supply. The front doors which cover compartments containing tuning or control adjustments are not interlocked, as all controls are at ground potential. Glass panels in the rear doors permit inspection of the inside of the transmitter while it is in operation. The driver tubes and the power amplifier tubes are visible through the upper front glass door while they are in operation. The high voltage rectifier tubes are likewise visible through the lower front glass door.

V. MECHANICAL DATA

Cubicle overall dimensions	66" wide, 34" deep, 74" high
Clearance for opening doors	26" on front and 32" on rear
Weight of cubicle	Approximately 1,900 lbs.

VI. GENERAL DESCRIPTION

The transmitter is completely contained in its cubicle, the only external connections being the 208-240 volt, 3 phase, power input, the 115 volt a.c. power input for crystal heaters and the convenience outlet, the program input line, the r.f. output line for connecting the modulation monitor and frequency meter, and the co-axial line to the radiating system. The type MO Modulated Oscillator Unit and the Type MP Frequency Stabilizer Unit contain the exciter and frequency stabilizing circuits. These units are of the plug-in type and may be easily removed from the cubicle. All of the other transmitter circuits are wired into the cubicle in such a manner that all portions are readily accessible.

VII. TYPE MO FREQUENCY MODULATED OSCILLATOR

This plug-in unit is located behind the lower left front door and may be removed by loosening four thumb-screws and sliding it from the cubicle by means of the pull handles attached. All electrical connections to the unit including co-axial lines are made by means of a plug at the rear of the unit. Access may be had to the unit without removing it from the cubicle. This is done by opening the cubicle rear doors, loosening two captive thumb-screws, and removing the protective dust cover from the rear of the unit. The modulated oscillator and modulator circuits are protected from extraneous vibrations and jarring by being completely shockmounted. The tuning knobs on the front panel are vernier controls which are used in tuning the unit once it has been adjusted for the assigned frequency. The switch on the front panel is for inserting or removing the pre-emphasis circuit. The two meters indicate the tuning of the feedback discriminator, the other meters for the modulator, oscillator and amplifier circuits being grouped with other meters of similar importance on the cubicle control panel. The circuits contained in this unit include the following.

a. Audio amplifier

b. Modulator control

c. Modulator

d. Oscillator/tripler

e. Feedback discriminator

f. Tripler

g. Intermediate amplifier

A type 1614 tube is used in the electron-coupled oscillator which triples the frequency in its plate circuit. The second r.f. stage, using a type 829 tube, is a push-pull tripler, which is followed by a push-pull intermediate amplifier stage using another type 829 tube from which excitation is taken from the unit to the driver. An inverse feed-back loop around the oscillator,

audio amplifier and modulator is accomplished by means of the feedback discriminator using a type 6H6 tube. The modulator is of the diode type which has more freedom from noise effects than the conventional reactance tube modulator. In this circuit a type 6H6 tube as modulator is controlled by a type 1614 tube which has the modulating signal impressed on its grid. The audio amplifier consists of a type 6SJ7 tube in a resistance-coupled circuit.

The r.f. amplifier circuits are designed so that short and symmetrical interconnections obtain and yet all components are easily accessible. All tubes are readily replaceable.

The plate power for the audio amplifier, modulator and oscillator/tripler is obtained from an electronically regulated supply. All circuits are shielded to prevent undesired coupling and radiation.

The modulated oscillator is operated at one-ninth of the assigned frequency of the transmitter. It has been found that simple tuned circuits in the multiplier stages provide adequate selectivity without cutting the side bands when the modulation is applied in this region. If frequencies very much lower were used, special band pass filters would have to be employed to provide the band width and selectivity at the same time.

VIII. TYPE MP FREQUENCY STABILIZER

This unit is likewise plug-in and is located behind the lower right front door. It is removable in the same manner as the Type MO Frequency Modulated Oscillator and is also accessible from the rear of the cubicle by loosening two captive thumb-screws and removing the dust cover from the unit.

This unit also contains the two plug-in crystal oscillator units, either of which may be selected by a switch on the front panel of the Frequency Stabilizer Unit.

Each crystal is mounted in one of the newly developed Bliley TC92 plug-in units which contains a thermostat supplied by Westinghouse. This unit will maintain crystal temperature within $\pm 1^{\circ}C.$ at any ambient temperature between minus $20^{\circ}C.$ and plus $65^{\circ}C.$ The frequency stability of the unit is in the order of $\pm$ .0005% or better after the oven has reached operating temperature. The crystal heaters operate from 115 volts a.c. and are connected so that continuous thermostatically controlled operation may be maintained.

The crystal oscillator employs a type 1614 tube in an electron coupled circuit and is conservatively operated at low voltage. Output is taken from the plate circuit of the oscillator at twice the crystal frequency. It may be noted that the fundamental crystal frequency is one-eighteenth of the assigned operating frequency, and that output from the crystal oscillator is at the center frequency of the modulated oscillator which is one-ninth of the assigned frequency. The crystal oscillator output is fed through two 45 degree phase shift networks, each consisting of one resistor and one capacitor. One of these networks shifts the phase forward by 45 degrees and the other retards the phase by the same

amount. R.f. voltage from the modulated oscillator is introduced into the Frequency Stabilizer unit through a fixed-tuned buffer amplifier stage employing a type 6SJ7 tube. The output of this stage is mixed with the quadrature voltages from the phase shift networks in two type 6SA7 mixer tubes. The output of one mixer tube after being amplified through one-half of a type 6SN7 is used to trigger a type 6SN7 direct coupled multivibrator. This multivibrator serves as an electronic switch to make square waves from the sine wave input from the mixer. Since the input to the multivibrator is much greater than the amount required to trigger it, the time at which the multivibrator turns over will be approximately the time at which the voltage of the output of its exciting mixer passes through zero. At this time the output of the other mixer is at either a positive or negative peak.

The voltage on each of the two multivibrator plates is differentiated by a series capacitor and shunt resistor. The resultant two voltages appear as a series of pulses of opposite polarity. These two pulse outputs are introduced into the two halves of a type 6H6 pulse discriminator. Also introduced into this pulse discriminator is the output of the second mixer through one-half of an intervening type 6SN7 amplifier. The bias on the pulse discriminator is set just above the peak value of the amplified output of the second mixer. The result is that when the pulses add to the sine wave, the bias is overcome and the pulse is passed through the diode. When the pulse subtracts from the sine wave, the bias prevents the diodes from conducting and the pulse is not passed. This arrangement serves to separate the pulses into two circuits. One circuit is energized by one pulse for each cycle of beat when the signal frequency is high, and the other circuit is energized by one pulse for each cycle of beat when the signal frequency is low.

Each output of the pulse discriminator is fed into one section of a type 6SL7 pulse amplifier/limiter, the output of which is controlled by an additional 6H6 pulse limiter. From this point the two pulse outputs are fed into two type 6H6 pulse counters arranged in a balanced circuit to control the charge in a storage capacitor. The voltage across the storage capacitor is applied to the two grids of a type 6SL7 dual cathode follower, one section of which controls the bias on the FM modulator tube in the Frequency Modulated Oscillator unit previously described. Since the modulator tube controls the frequency of the modulated oscillator, the frequency is a direct function of the charge on the storage capacitor. There is no bleeder resistor across this storage capacitor, hence the system has no natural frequency which the frequency control must overcome.

If the average frequency of the modulated oscillator is different from the reference frequency, the charge on the storage capacitor is continually changed in the direction to overcome the difference. When the difference has been overcome, the system becomes balanced, and the only tendency to pull off is due to stray leakages which cause negligible frequency drift.

There are a number of advantages offered by this circuit, perhaps the most important of which is the lack of tuned circuits and critical components. The frequency controlling circuits by themselves contain no tuned circuits, frequency dividers, or locked oscillators. No test instruments are needed to place these circuits in operation. Another important advantage is that tube characteristics are not important. Since each tube in the circuit is driven from grid current to cut-off, merely acting as an electronic switch, the actual condition of the tubes becomes relatively unim-

portant. Long before any tube would become inoperative in the circuit, it would be discarded because of routine tube checks.

The controls on the front panel of the Frequency Stabilizer Unit are the crystal oscillator selector switch and the frequency control off-on switch *(which enables the disconnection of the frequency correction voltage.)* One meter indicates mixer grid current and thus shows input to the unit from the modulated oscillator, the other meter indicating the cathode current of the crystal oscillator in use. The indicating lamp shows when the frequency control switch is in the "on" position.

IX. CUBICLE CIRCUITS

Access to the tubes in the electronic voltage regulator for the modulated oscillator power supply may be had by opening the top front glass door. These tubes are located on the left end of the upper shelf. This regulator furnishes well-regulated plate voltage with extremely low ripple content for the modulated oscillator and modulator.

In the adjacent compartment on the upper shelf are mounted the two 4-250A driver tubes. The driver grid circuit components are located underneath the shelf where short and direct interconnections obtain. The trough-line plate tank for the driver stage is located directly above the driver tubes. This tank circuit is arranged in such a manner that no blocking capacitors are used in the shunt-fed plate circuit. Both the grid and plate tank circuits of the driver are motor tuned, with the controls mounted on the main control panel. The manual control for tuning the driver screen grid is located on the driver grid assembly located behind the control panel. The correct adjustment of this capacitor is easily accomplished by tilting the hinge control panel forward. After adjusting this condenser the control is locked in place as no further adjustment of this capacitor is necessary.

To the right of the driver tubes are located the two WL473 power amplifier tubes with their grid series-tuning capacitors. The controls for adjusting the two power amplifier grid series-tuning capacitors are located on each side of the forward end of the PA Tank Line. As in the case of the driver screen grid tuning control these controls are accessible by tilting the hinge control panel forward. After being properly adjusted these controls are locked in place as further adjustment of this tuning control is necessary. The adjustment of these grid series-tuning capacitors is simple and has none of the complexity of conventional neutralizing adjustments. Since the grounded-grid circuit is used in the power amplifier stage, excitation is applied to the cathode lines of the power amplifier which are located just above the power amplifier tubes. The anode of each tube fits down into the end of its anode line which is arranged so as to use no blocking capacitor. The anode line tuning and output coupling are both motor driven, with controls being located on the main control panel.

A flexible co-axial line connects from the variable output coupling arrangement to the r.f. transmission-line voltmeter capacity-divider and meter rectifier unit. The other end of this unit has provision for mounting an

appropriate end-seal and terminating the transmission line to the radiating system. One type 9006 tube is used as the voltmeter rectifier.

Cooling air intake is through the protected round ports in the rear of the base. From these ports, air passes up through the bottom of the cubicle, through a filter box, around the high voltage transformers, and into the blower. From the blower, air passes through a duct to the plenum chamber from whence it flows through the anode fins of the two WL473 tubes and also over the seals of the two driver tubes. Air is exhausted through a screened port in the top of the cubicle.

Overload and under-voltage protection is supplied in all circuits where necessary.

The supervisory control system consists of a series of relays and indicator lamps so connected that the operation of any overload relay operates a corresponding supervisory relay which locks itself in, lighting the corresponding indicator lamp. This indication remains on the control panel until reset by the operator. This system enables the operator to tell at a glance in which circuit the overload occurred, even though the transmitter has returned to the air. This is particularly useful in checking for the possible cause of the outage.

Thorough protective interlocking is used with dependable relays, switches and contactors. The control system is interlocked so that it is impossible to apply power in the wrong sequence. Sufficient indicators are provided so that proper sequence can be easily followed.

All main power switches are of the De-ion type with thermal-overload release. This gives full protection of the power circuits without the use of fuses. A positive indication is given when tripped by overload in that the switch handle assumes a position in the middle of the slot. This protection is in addition to the protection given by the numerous overload relays employed throughout the major circuits of the equipment.

The filament, low-voltage and high-voltage rectifiers may be controlled from a remote point. Provision is also made for indicator lamps at the remote point.

The main control panel is located behind the folding drop-leaf door on the front of the cubicle. When opened, this door provides a convenient arm rest for the operator and is useful for supporting writing pads or logs while entering meter readings.

The indicators at the left of the control panel are the supervisory overload and under voltage indicators, with the supervisory indicator reset switch located below them. To the right of these indicators are the driver grid tuning indicator and control, the driver plate tuning indicator and control, and the 3KW AMP plate tuning indicator and control. The central group of meters indicate plate and grid currents of the tubes in the Type MO Modulated Oscillator Unit mounted below. Below these meters are the crystal power "on" indicator and the two crystal heater indicators. On the right of this group of meters and indicators are the transmission line coupling indicator and control, and the bus phase voltmeter and switch for inserting the voltmeter

across any of the three phases. Adjacent to the voltmeter on the right is the 230 v. bus regulator control, and below this control are the air indicator and the high voltage regulator control. In the group of nine indicators and switches at the right of the control panel are the filament power switch and "ready" and "on" indicators, the 400 volt switch and "ready" and "on" indicators, and the high voltage switch and "ready" and "on" indicators.

The wide-scale, easily read meters at the top of the cubicle indicate, reading from left to right, driver grid current, driver plate current, power amplifier grid current, power amplifier plate current, high voltage, and transmission line voltage. These meters have 270^{o} scales and are illuminated for optimum readability by means of fluorescent lights in the trough below and immediately in front of the meters.

The high voltage and low voltage rectifier tubes may be seen through the lower front glass door, through which they may be quickly replaced in the event of tube failure. On the upper shelf, in the compartment to the right of the power amplifier tube are receptacles for storing spare rectifier, driver and power amplifier tubes.

Motor driven line voltage regulators are used on both the auxiliary bus and the high voltage supply. By means of the regulator in the high voltage supply, the output power may be reduced from rated power to one kilowatt. The filter capacitors in both high and low voltage supplies are made up by paralleling low capacity units. In the event of failure of one section, it may be cut out of the circuit and operation continued. Also, the cost of replacing a single unit is considerably less.

All appropriate cubicle wiring is done with high grade lead-covered wire. This results in a neat and clean wiring job. Further advantages are freedom from cross-talk and extraneous pick-up.

Long-lived Class B *(mica and glass)* insulation is used in all power transformers and reactors, however, all of these components are operated under low-temperature-rise, Class A conditions so that the maximum possible service life is to be expected.

X. INSTRUCTION BOOKS

Each equipment will be supplied with two copies of the instruction book for the Westinghouse FM-3 Transmitter. This instruction book will contain complete adjustment and operation information in sufficient detail to assure correct procedure by reasonably skilled operating personnel. It will be complete with schematic diagrams. The information furnished will be in sufficient detail to be readily usable in installation, servicing and maintenance.

A complete list of electrical parts with ordering information will be included to simplify replacement of electrical parts, or expendable items or parts thereof.

A list of recommended spare parts will be supplied which should cover ordinary service requirements for two years.

XI. IMPROVEMENTS

In the construction of the equipment described in this specification, the full intent of the specification will be carried out. However, it is assumed that any minor changes which may be found desirable later for reasons of improved design or construction will be accepted.

The Westinghouse Electric Corporation reserves the right to make changes in design or to make additions to or improvements in its products without imposing any obligation upon itself to install them on its products previously manufactured.

XII. SAMPLE CONSTRUCTION PERMIT

As an aid in preparing FCC Form Number 319, there are attached sample pages 27 and 28 from this form.

TECHNICAL INFORMATION

Description of transmitting apparatus proposed to be installed:

(a) Make *Westinghouse Electric Corp.* Type No. *FM-3*

(b) Oscillator: Type of Circuit *Colpitts* Number, make and type of tubes *One RCA type 1614 in electron-coupled Colpitts circuit.*

(c) List buffer and intermediate power amplifier stages, by number and type of tubes in each stage *One RCA 829 tripler, one RCA 829 intermediate amplifier, Two Eimac 4-125 driver amplifier.*

(d) Last radio stage: Number, make and type of tubes *Two Westinghouse WL473*

(e) Modulator or last audio stage: Number, make and type of tubes and how modulation is obtained *One RCA 1614 and one RCA 6H6. Resistance-capacity frequency modulation of oscillator.*

(f) The transmitter is designed for what maximum swing *±100* kilocycles

(g) State make and type number of modulation monitor *To be specified by applicant*

(h) Specify make, type number, and full-scale reading of the following meters:

(1) In last radio stage:
Plate voltmeter *Westinghouse Type KX-24 0-3000 V.D.C.*
Plate ammeter *Westinghouse Type KX-24 0-3 Amps.*

(2) Antenna or transmission line meter *Westinghouse Type KX-24 0-500 Volts R.F.*

(i) Maximum rated power output of transmitter is *3000* watts

(j) Give the following overall characteristics of the transmitter:

(1) Frequency characteristic: uniform within 1 decibels of 1000 cycle level within the range from 30 to 15000 cycles. without pre-emphasis.

(2) Amplitude characteristics: Distortion 1.5 percent RMS harmonics within the range from 50 to 15000 cycles. 1% harmonics from 100 to 7500 cycles.

(3) Noise level (Frequency modulation) 65 decibels below 100 percent modulation (30 to 15000 cycles).

(4) Noise level (amplitude modulation) 50 decibels below 100 percent modulation (30 to 15000 cycles).

(5) Will a pre-emphasis circuit be used in the transmitter by which the higher frequencies will be emphasized in accordance with the impedance-frequency characteristics of a series inductance-resistance circuit having a time constant of 100 microseconds *Yes* The frequency characteristics of the transmitter with the pre-emphasis circuit will be within 1 decibel of the calculated characteristics of such circuit.

Description of automatic frequency control equipment:

(a) Make *Westinghouse Electric Corp.* Type No. *MP*

(b) Give make, type of cut and temperature coefficient in cycles per degree centigrade if quartz crystal used *Bliley Type TC-92, Type BT-low temp. coefficient 1 cycle/Mc/°C.*

(c) By whom will unit be calibrated? *Westinghouse Electric Corp.* Calibrated Frequency: * kilocycles at _____ degrees centigrade.
**To be specified by applicant, determined by assigned freq.*

(d) State number of frequency control oscillators which will be maintained constantly at correct operating temperature and frequency in heat-controlled chambers *Two*

(e) Is provision made for instantaneous connection of spare frequency control units? *Yes*

(f) State make and type number of separate frequency monitor *to be specified by applicant.*

Descriptive Specification

WESTINGHOUSE

FM-10

10KW FREQUENCY MODULATED BROADCAST TRANSMITTER

WESTINGHOUSE ELECTRIC CORPORATION
Industrial Electronics Division — Baltimore, Maryland

April 15, 1946 — *R-1508-A*

TABLE OF CONTENTS

I. GENERAL INTRODUCTION

The FM-10 transmitter comprises the FM-3 transmitter as the left end cubicle with the high voltage rectifier cubicle in the center and the power amplifier cubicle on the right hand side. The complete transmitter was designed from its inception for the frequency band of 88 to 108 mc/s. The 10 kw. power amplifier utilizes two of the new Westinghouse WL479 tubes which were designed specifically for this transmitter.

The advanced circuit developments incorporated in this transmitter result in exceptional performance characteristics, reliability of operation, and simplicity of adjustment. There have been no compromises with low frequency techniques.

The new electrical design is supplemented by a sound mechanical design which provides ready accessibility of all apparatus, rugged construction, and distinctive appearance.

The following outstanding features of the transmitter are typical of the advantages offered:

1. Direct generation of the modulated carrier by a simple and straightforward circuit.
2. Crystal-derived center-frequency stabilization independent of circuit tuning.
3. Extremely conservative ratings on all power transformers.
4. Complete fuseless overload protection.
5. Automatic sequence starting.
6. No oil cooled components.
7. Supervisory control.
8. Low operating cost.
9. Ease of maintenance.
10. Lead covered wire used for all cubicle wiring where appropriate.
11. Conservative operation of tubes and components.
12. None but the finest quality components used.
13. May be easily adapted for higher power by adding a 50 kw. amplifier unit.

II. ELECTRICAL SPECIFICATIONS

Carrier power output (nominal)	10,000 watts
Carrier frequency (single specified frequency)	88 to 108 mc/s

Frequency stability	Better than ±1,000 cps
Output line impedance	51.5 ohm line in accordance with RMA standards
Modulation capability	±100 kc/s
Audio frequency response (30 to 15,000 cycles)	Without pre-emphasis, ±1 db from response at 1,000 cycles; with pre-emphasis, ±1 db from 75 microsecond curve.
Audio input for ± 75 kc/s carrier swing	+ 10 dbm at 400 cycles
Audio input impedance	600/150 ohms
Harmonic distortion (including all harmonics up to 30 kc/s at ± 75 kc/s swing)	Less than 1.0% rms for modulating frequencies between 100 and 7,500 cps. Less than 1.5% rms for frequencies between 50 and 100 cycles and between 7,500 and 15,000 cycles.
FM noise level	At least 65 db below ± 75 kc/s swing
AM noise level	At least 50 db below 100% am
Power supply	208-240 volts, 50 or 60 cycles, 3 phase; 115 volts, 50/60 cycles, single phase for crystal heaters.
Power input	31 kw at 90% power factor for full output.

III. TUBE COMPLEMENT

Type MO Frequency Modulated Oscillator

Audio amplifier	1 Type 6SJ7
Modulator control	1 Type 1614
Modulator	1 Type 6H6
Feedback discriminator	1 Type 6H6
FM oscillator/tripler	1 Type 1614
Tripler	1 Type 829B

Intermediate amplifier	1 Type 829B
Type MP Frequency Stabilizer	
Buffer amplifier	1 Type 6SJ7
#1 crystal oscillator	1 Type 1614
#2 crystal oscillator	1 Type 1614
#1 mixer	1 Type 6SA7
#2 mixer	1 Type 6SA7
Amplifier	1 Type 6SN7
Pulse generator	1 Type 6SN7
Pulse discriminator	1 Type 6H6
Pulse amplifier/limiter	1 Type 6SL7
Pulse limiter	1 Type 6H6
Balanced pulse counter	2 Type 6H6
Cathode follower	1 Type 6SL7
Voltage regulator	1 Type OD3/VR150 1 Type OC3/VR105
Bias rectifier	1 Type 6X5
Bias regulator	1 Type OC3/VR105
Low Voltage Regulator	
Regulator	2 Type 6Y6G
Regulator control	1 Type 6SJ7
Control bias	1 Type OC2/VR105
Low Voltage Rectifier	2 Type 866A
Intermediate voltage rectifier	6 Type 872A
Intermediate amplifier	2 Type 4-125A
Driver amplifier	2 Type WL-473
RF voltmeter rectifier	1 Type 9006
Power amplifier bias rectifier	2 Type 5U4-G
High Voltage rectifier	6 Type WE-267B
10 kw power amplifier	2 Type WL-479

IV. MECHANICAL SPECIFICATIONS

The complete transmitter is enclosed in three heavy-gauge sheet-aluminum cubicles. The construction of these cubicles is such that they comprise a unified, integrated design when assembled together on a four inch sub-base. The resulting transmitter is attractively styled and finished in harmonious blue-gray and gray. All doors which permit access to parts at dangerous potentials are interlocked. The front doors which cover compartments containing tuning or control adjustments are not interlocked, as all controls are at ground potential. Glass panels in the rear doors permit inspection of the inside of the transmitter while it is in operation. The second intermediate amplifier and driver tubes are visible through the upper front glass door of the left cubicle while they are in operation. The intermediate voltage rectifier tubes are visible through the lower front glass door of this cubicle. The high voltage tubes and power amplifier tubes are visible behind the safety glass in the fronts of their respective cubicles.

Drawing M-7423317 gives the mechanical layout which is recommended for a normal type of installation. It is, however, recognized that in some installations an "in line" layout may prove undesirable. In such cases the rectifier cubicle can be located remote from the exciter and power amplifier.

It will be noted that a four inch high sub-base is supplied upon which the three cubicles can be mounted. While this sub-base can be omitted, it is recommended that it be used for ease of installation and alignment.

If a purchaser installs a Westinghouse 3 KW, Type FM-3 transmitter in advance of the rectifier and power amplifier, it is recommended that sufficient length be allowed on wiring so that the four inch high sub-base may be used at the time the balance of the two units are added.

When the sub-base is used, inter-cubicle wiring is accomplished by the installation of appropriate conduit within this sub-base. If the sub-base is not used, conduits are run through holes provided in the cubicle base, or through floor troughs. Troughs or conduit should be located along the rear edge of the cubicle bases.

V. MECHANICAL SPECIFICATIONS (APPROXIMATE)

Total overall dimensions	189" wide, 36" deep, 78" high
Side cubicle dimensions	66" wide, 34" deep, 74" high
Central cubicle dimensions (each)	66" wide, 36" deep, 74" high (Overlaps end cubicles)
Weight of exciter cubicle	Approximately 1,900 lbs.
Weight of power amplifier cubicle	Approximately 1,900 lbs.
Weight of high voltage rectifier cubicle	Approximately 2,700 lbs.

VI. GENERAL DESCRIPTION

The transmitter is completely contained in the three cubicles. The only external connections being the 208-240 volt, 3 phase, power input, the 115 volt a.c. power input for crystal heaters, the r.f. output line for connecting the modulation monitor and frequency meter, the program input line, and the co-axial line to the radiating system.

The Type MO Modulated Oscillator Unit and the Type MP Frequency Stabilizer Unit contain the low power exciter stages and the frequency stabilizing circuits, respectively. These units are of the plug-in type and are located in the left cubicle from which they may be removed easily. All of the other transmitter circuits are wired into the cubicles in such a manner that all portions are readily accessible.

VII. TYPE MO FREQUENCY MODULATED OSCILLATOR

This plug-in unit is located behind the lower left front door of the exciter and may be removed by loosening four thumb-screws and sliding it from the cubicle by means of the pull handles attached. All electrical connections to the unit including co-axial lines are made by means of a plug at the rear of the unit. Access may be had to the unit without removing it from the cubicle. This is done by opening the cubicle rear doors, loosening two captive thumb-screws, and removing the protective dust cover from the rear of the unit. The modulated oscillator and modulator circuits are protected from extraneous vibration and jarring by being completely shockmounted. The tuning knobs on the front panel are vernier controls which are used in tuning the unit once it has been adjusted for the assigned frequency. The switch on the front panel is for inserting or removing the pre-emphasis circuit. The two meters indicate the tuning of the feedback discriminator, the other meters for the modulator, oscillator and amplifier circuits being grouped with other meters of similar importance on the cubicle control panel. The circuits contained in this unit include the following:

a. Audio amplifier

b. Modulator control

c. Modulator

d. Oscillator/tripler

e. Feedback discriminator

f. Tripler

g. Intermediate amplifier

A Type 1614 tube is used in the electron-coupled oscillator which triples in its plate circuit. The second r.f. stage, using a Type 829-B tube, is a push-pull tripler, which is followed by a push-pull intermediate amplifier stage using another Type 829-B tube from which excitation is taken from the unit to the driver. An inverse feedback loop around the oscillator,

audio amplifier and modulator is accomplished by means of the feedback discriminator using a Type 6H6 tube. The modulator is of the diode type which has more freedom from noise effects than the conventional reactance tube modulator. In this circuit a Type 6H6 tube as modulator is controlled by a Type 1614 tube which has the modulating signal impressed in its grid. The audio amplifier consists of a Type 6SJ7 tube in a resistance-coupled circuit.

The r.f. amplifier circuits are designed so that short and symmetrical interconnections obtain and yet all components are easily accessible. All tubes are readily replaceable.

The plate power for the audio amplifier, modulator and oscillator/tripler is obtained from an electronically regulated supply. All circuits are shielded to prevent undesired coupling and radiation.

The modulated oscillator is operated at one-ninth of the assigned frequency of the transmitter. It has been found that simple tuned circuits in the multiplier stages provide adequate selectivity without cutting the side bands when the modulation is applied in this region. If frequencies very much lower were used, special band pass filters would have to be employed to provide the bandwidth and selectivity at the same time.

VIII. TYPE MP FREQUENCY STABILIZER

This unit is likewise plug-in and is located behind the lower right front door of the exciter. It is removable in the same manner as the Type MO Frequency Modulated Oscillator and is also accessible from the rear of the cubicle by loosening two captive thumb-screws and removing the dust cover from the unit.

This unit also contains the two plug-in crystal oscillator units, either of which may be selected by a switch on the front of the Frequency Stabilizer Unit.

Each crystal is mounted in one of the newly developed Bliley TC92 plug-in units which contains a thermostat supplied by Westinghouse. This unit will maintain crystal temperature within $\pm 1^{o}$C. at any ambient temperature between minus 20^{o}C. and plus 65^{o}C. The frequency stability of the unit is in the order of ±.0005% or better after the oven has reached operating temperature. The crystal heaters operate on 115 volts a.c. and are connected so that continuous thermostatically controlled operation may be maintained.

The crystal oscillator employs a Type 1614 tube in an electron coupled circuit and is conservatively operated at low voltage. Output is taken from the plate circuit of the oscillator at twice the crystal frequency. It may be noted that the fundamental crystal frequency is one-eighteenth of the assigned operating frequency, and that output from the crystal oscillator is at the center frequency of the modulated oscillator which is one-ninth of the assigned frequency. The crystal oscillator output is fed through two 45 degree phase shift networks, each consisting of one resistor and one capacitor of approximately the same number of ohms. One of these networks shifts the phase forward by 45 degrees and the other retards the phase by the same

amount. R.F. voltage from the modulated oscillator is introduced into the Frequency Stabilizer unit through a fixed-tuned buffer amplifier stage employing a Type 6SJ7 tube. The output of this stage is mixed with the quadrature voltages from the phase shift networks in two Type 6SA7 mixer tubes. The output of one mixer tube after being amplified through one-half of a Type 6SN7 is used to trigger a Type 6SN7 direct coupled multivibrator. This multivibrator serves as an electronic switch to make square waves from the sine wave input from the mixer. Since the input to the multivibrator is much greater than the amount required to trigger it, the time at which the multivibrator turns over will be approximately the time at which the voltage of the output of its exciting mixer passes through zero. At this time the output of the other mixer is at either a positive or negative peak.

The voltage on each of the two multivibrator plates is differentiated by a series capacitor and shunt resistor. The resultant two voltages appear as a series of pulses of opposite polarity. These two pulse outputs are introduced into the two halves of a Type 6H6 pulse selector. Also introduced into this pulse selector is the output of the second mixer through one-half of an intervening Type 6SN7 amplifier. The bias on the pulse discriminator is set just above the peak value of the amplified output of the second mixer. The result is that when the pulses add to the sine wave, the bias is overcome and the pulse is passed through the diode. When the pulse subtracts from the sine wave, the bias prevents the diodes from conducting and the pulse is not passed. This arrangement serves to separate the pulses into two circuits. One circuit is energized by one pulse for each cycle of beat when the signal frequency is high, and the other circuit is energized by one pulse for each cycle of beat when the signal frequency is low.

Each output of the pulse selector is fed into one section of a Type 6SL7 pulse amplifier/limiter, the output of which is controlled by an additional 6H6 pulse limiter. From this point, the two pulse outputs are fed into two Type 6H6 pulse counters arranged in a balanced circuit to control the charge in a storage capacitor. The voltage across the storage capacitor is applied to the two grids of a Type 6SL7 dual cathode follower, one section of which controls the bias on the FM modulator tube in the Frequency Modulated Oscillator unit previously described. Since the modulator tube controls the frequency of the modulated oscillator, the frequency is a direct function of the charge on the storage capacitor. There is no bleeder resistor across this storage capacitor, hence the system has no natural frequency which the frequency control must overcome.

If the average frequency of the modulated oscillator is different from the reference frequency, the charge on the storage capacitor is continually changed in the direction to overcome the difference. When the difference has been overcome, the system becomes balanced, and the only tendency to pull off is due to stray leakages which cause negligible frequency drift.

There are a number of advantages offered by this circuit, perhaps the most important of which is the lack of tuned circuits and critical components. The frequency controlling circuits by themselves contain no tuned circuits, frequency dividers, or locked oscillators. No test instruments are needed to place these circuits in operation. Another important advantage is that tube characteristics are not important. Since each tube in the

circuit is driven from grid current to cut-off, merely acting as an electronic switch, the actual condition of the tubes becomes relatively unimportant. Long before any tube would become inoperative in the circuit, it would be discarded because of routine tube checks.

The controls on the front panel of the Frequency Stabilizer Unit are the crystal oscillator selector switch, the plus or minus static deviation switch (which enables the insertion of a static frequency deviation for testing purposes), and the frequency control off-on switch (which enables the disconnection of the frequency correcting voltage). One meter indicates mixer grid current and thus shows input to the unit from the modulated oscillator, the other meter indicating the cathode current of the crystal oscillator in use. The indicating lamp shows when the frequency control switch is in the "on" position.

IX. EXCITER CUBICLE

Access to the tubes in the electronic voltage regulator for the modulated oscillator power supply may be had by opening the left end of the upper shelf. This regulator furnishes well-regulated plate voltage with extremely low ripple content for the modulated oscillator and modulator.

In the adjacent compartment on the upper shelf are mounted the two 4-125A intermediate amplifier tubes. The grid circuit components of these tubes are located underneath the shelf where short and direct inter-connections obtain. The trough-line plate tank for the intermediate amplifier stage is located directly behind the tubes, on the rear of the compartment wall. This tank circuit is arranged in such a manner that no blocking capacitors are used in the shunt-fed plate circuit. Both the grid and plate tank circuits of the amplifier are motor tuned, with the controls mounted on the main control panel. Motor driven variable coupling between the intermediate amplifier plate tank and the driver amplifier cathode lines provides continuously variable interstage coupling. The intermediate amplifier screen-grid series tuning capacitors are accessible through the control panel. The correct adjustment of these series tuning capacitors is quite easily accomplished and precludes any possibility of oscillation in the intermediate amplifier.

To the right of the intermediate amplifier tubes are located the two WL-473 driver amplifier tubes with their grid series-tuning capacitors. These capacitors are adjusted through the main control panel and their correct adjustment prevents any tendency toward oscillation in the driver stage. The adjustment of these grid series-tuning capacitors is simple and has none of the complexity of conventional neutralizing adjustments. Since the grounded-grid circuit is used in the driver amplifier stage, excitation is applied to the cathode lines of the driver which are located on the rear wall of the compartment, just back of the driver tubes. The anode of each tube fits down into the end of its anode line which is arranged so as to use no blocking capacitor. The anode line tuning and output coupling are both motor driven, with controls being located on the main control panel of the exciter.

A flexible co-axial line connects from the variable output coupling arrangement to the power amplifier grid circuit in the power amplifier cubicle.

X. HIGH VOLTAGE RECTIFIER CUBICLE

In the high voltage rectifier cubicle, six Type WE-267B tubes are used in a three phase full wave circuit. This cubicle also contains the high voltage rectifier transformers, the rectifier filament transformers, the high voltage filter components, the motor-driven high-voltage line regulator, and the associated switching and overload protection devices. The rectifier tubes are visible while in operation so that an outage caused by them can be quickly detected. All components are readily accessible through the cubicle rear door.

The line circuits of all power equipment are protected by "De-ion" circuit breakers, which also serve as power isolation switches to de-energize the apparatus during maintenance and standby periods. The breakers in the incoming power circuits have an interrupting capacity of 15,000 amperes.

Fast operating overload relays in the cathode circuits of the intermediate amplifiers, driver, and power amplifier tubes remove plate power from these stages in the event that currents exceeding tube ratings result from any cause.

All doors giving access to circuits operating at potentials above 250 volts are equipped with electrical interlocks which remove dangerous voltages when the doors are open.

XI. POWER AMPLIFIER CUBICLE

Two Type WL-479 tubes develop the 10 KW carrier output of this equipment; these are forced air cooled tetrodes with external anodes, a type of construction which minimizes plate-lead inductance. The inductance of the grid and cathode leads has likewise been made very low, the filament having concentric terminals. The screen grid inductance is reduced by a ring type seal. These tubes were developed for this particular transmitter so as to provide high efficiency at the frequencies involved. These tubes are visible while in operation through the safety-glass window in the front of the cubicle. Motor operated tuning controls are provided for the tank circuits, the screen-grid series-tuning capacitors, and for varying the coupling to the antenna feed line. Also contained in this cubicle are the power amplifier grid bias supply and the r.f. voltmeter for reading transmission line voltage. A self contained blower which draws air through a replaceable filter provides cooling air for the tubes. All of the components in the cubicle are readily accessible through the cubicle rear door.

Overload and under-voltage protection is supplied in all circuits where necessary. The supervisory control system consists of a series of relays and indicator lamps so connected that the operation of any overload relay operates a corresponding supervisory relay which locks itself in, lighting the corresponding indicator lamp. This indication remains on the control panel until reset by the operator. This system enables the operator

to tell at a glance in which circuit the overload occurred, even though the transmitter has returned to the air. This is particularly useful in checking for the possible cause of the outage.

Thorough protective interlocking is used with dependable relays, switches and contactors. The control system is inter-locked so that it is impossible to apply power in the wrong sequence. Sufficient indicators are provided so that proper sequence can be easily followed. The filament, low-voltage, intermediate voltage, and the high voltage rectifiers may be controlled from a remote point. Provision is also made for indicator lamps at the remote point.

The filter capacitors in both high and low voltage supplies are made up by paralleling low capacity units. In the event of failure of one section, it may be cut out of the circuit and operation continued. Also, the cost of replacing a single unit is considerably less.

All appropriate cubicle wiring is done with high grade lead-covered wire. This results in a neat and clean wiring job. Further advantages are freedom from cross-talk and extraneous pick-up.

Long-lived Class B (mica and glass) insulation is used in all power transformers and reactors, however, all of these components are operated under low-temperature-rise, Class A, conditions so that the maximum possible service life is to be expected.

XII. INSTRUCTION BOOK

Each equipment will be supplied with two copies of the Instruction Book for the Westinghouse FM-10 Transmitter. This instruction book contains complete adjustment and operation information in sufficient detail to assure correct procedure by reasonably skilled operating personnel. It is complete with schematic diagrams. The information furnished is in sufficient detail to be readily usable in installation, servicing and maintenance. A complete list of electrical parts with ordering information is included to simplify replacement of electrical parts, or expendable items or parts thereof.

A list of recommended spare parts is supplied which should cover ordinary service requirements for two years.

XIII. IMPROVEMENTS

In the construction of the equipment described in this specification, the full intent of the specification will be carried out. However, it is assumed that any minor changes which may be found desirable later for reasons of improved design or construction will be accepted.

The Westinghouse Electric Corporation reserves the right to make changes in design or to make additions to or improvements in its products without imposing any obligation upon itself to install them on its products previously manufactured.

XIV. CONSTRUCTION PERMIT

As an aid in preparing FCC Form Number 319, the following example indicates how pages 27 and 28 of Form 319 should be filled in.

TECHNICAL INFORMATION

Description of transmitting apparatus proposed to be installed:

(a) Make *Westinghouse Electric Corp.* Type No. *FM-10*

(b) Oscillator: Type of Circuit *Colpitts* Number, make and type of tubes *One RCA Type 1614 in electron-coupled Colpitts circuit, (triples in plate circuit).*

(c) List buffer and intermediate power amplifier stages, by number and type of tubes in each stage *One RCA 829-B tripler, one RCA 829-B intermediate amplifier. Two Eimac 4-125-A intermediate amplifier. Two WL-473 Driver Amplifier.*

(d) Last radio stage: Number, make and type of tubes *Two Westinghouse WL-479*

(e) Modulator or last audio stage: Number, make and type of tubes and how modulation is obtained. *One RCA 1614 and one RCA 6H6. Resistance-capacity frequency modulation of oscillator.*

(f) The transmitter is designed for what maximum swing *±100* kilocycles

(g) State make and type number of modulation monitor *To be specified by applicant.*

(h) Specify make, type number, full-scale reading of the following meters:

(1) In last radio stage:

Plate voltmeter *Westinghouse Type KX-24, 0-6000 V.D.C.*

Plate ammeter *Westinghouse Type KX-24, 0-5 amps. Westinghouse Type KX-24*

(2) Antenna or transmission line meter *0-1000 Volts R.F.*

(i) Maximum rated power output of transmitter is *10,000* watts

(j) Give the following overall characteristics of the transmitter:

(1) Frequency characteristic: Uniform within *1* decibels of 1000 cycle level within the range from 30 to 15,000 cycles, without pre-emphasis.

(2) Amplitude characteristics: Distortion *1.5* percent RMS harmonics within the range from 50 to 15,000 cycles. 1 percent harmonics from 100 to 7,500 cycles.

(3) Noise level (frequency modulation) *65* decibels below 100 percent modulation (30 to 15,000 cycles).

(4) Noise level (amplitude modulation) *50* decibels below 100 percent modulation (30 to 15,000 cycles).

(5) Will a pre-emphasis circuit be used in the transmitter by which the higher frequencies will be emphasized in accordance with the impedance-frequency characteristics of a series inductance-resistance circuit having a time constant of 75 microseconds?
Yes The frequency characteristics of the transmitter with the pre-emphasis circuit will be within *1* decibels of the calculated characteristics of such circuit.

Description of automatic frequency control equipment:

(a) Make *Westinghouse Electric Corp.* Type No. *MP*

(b) Give make, type of cut and temperature coefficient in cycles per degree centigrade if quartz crystal used *Bliley Type TC-92, Type BT-low temp. coefficient 1 cycle /Mc/°C.*

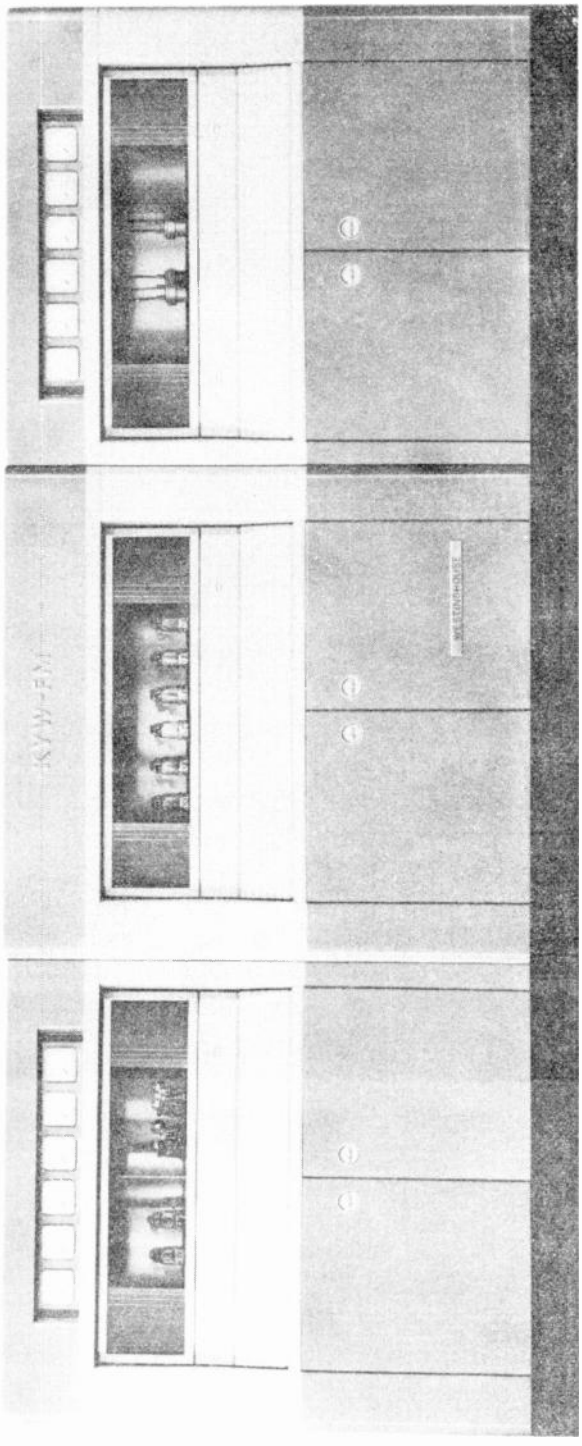
(c) By whom will unit be calibrated? *Westinghouse Electric Corp.*

Calibrated Frequency: * kilocycles at degrees centigrade.
*To be specified by applicant, determined by assigned frequency (1/18 of assigned frequency.)

(d) State number of frequency control oscillators which will be maintained constantly at correct operating temperature and frequency in heat-controlled chambers *Two*

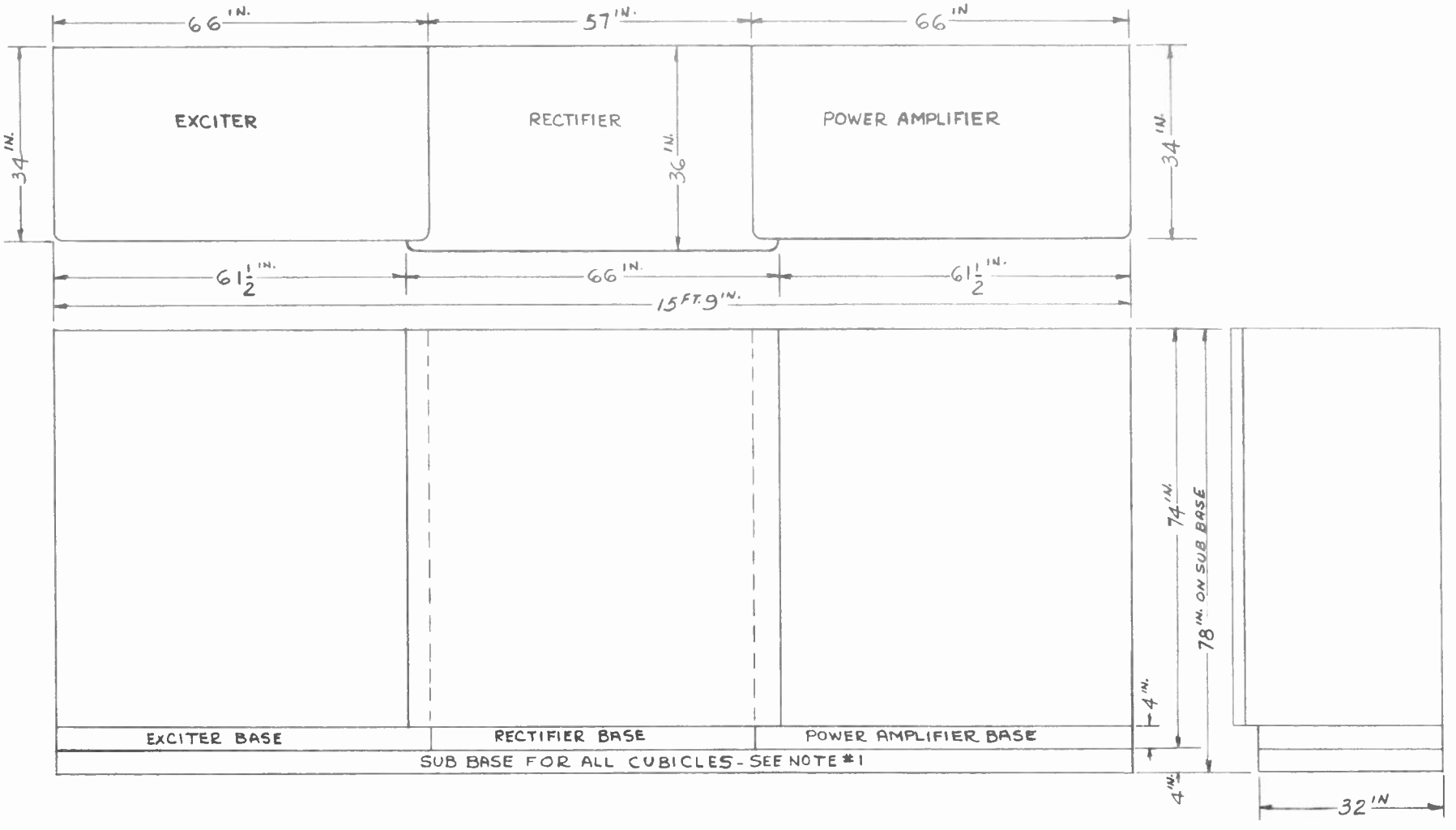
(e) Is provision made for instantaneous connection of spare frequency control units? *Yes*

(f) State make and type number of separate frequency monitor
To be specified by applicant.



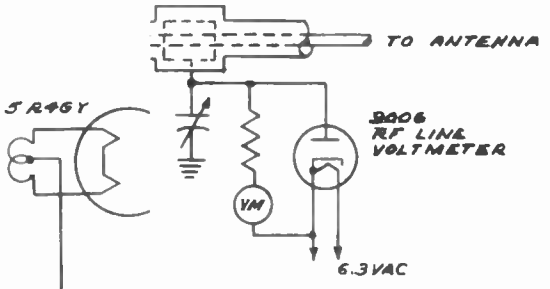
10 KW FM TRANSMITTER, FRONT VIEW
(Photo C-9766)

INSTALLATION OUTLINE DRAWING, 10 KW FM TRANSMITTER
(Dwg. 7423317)



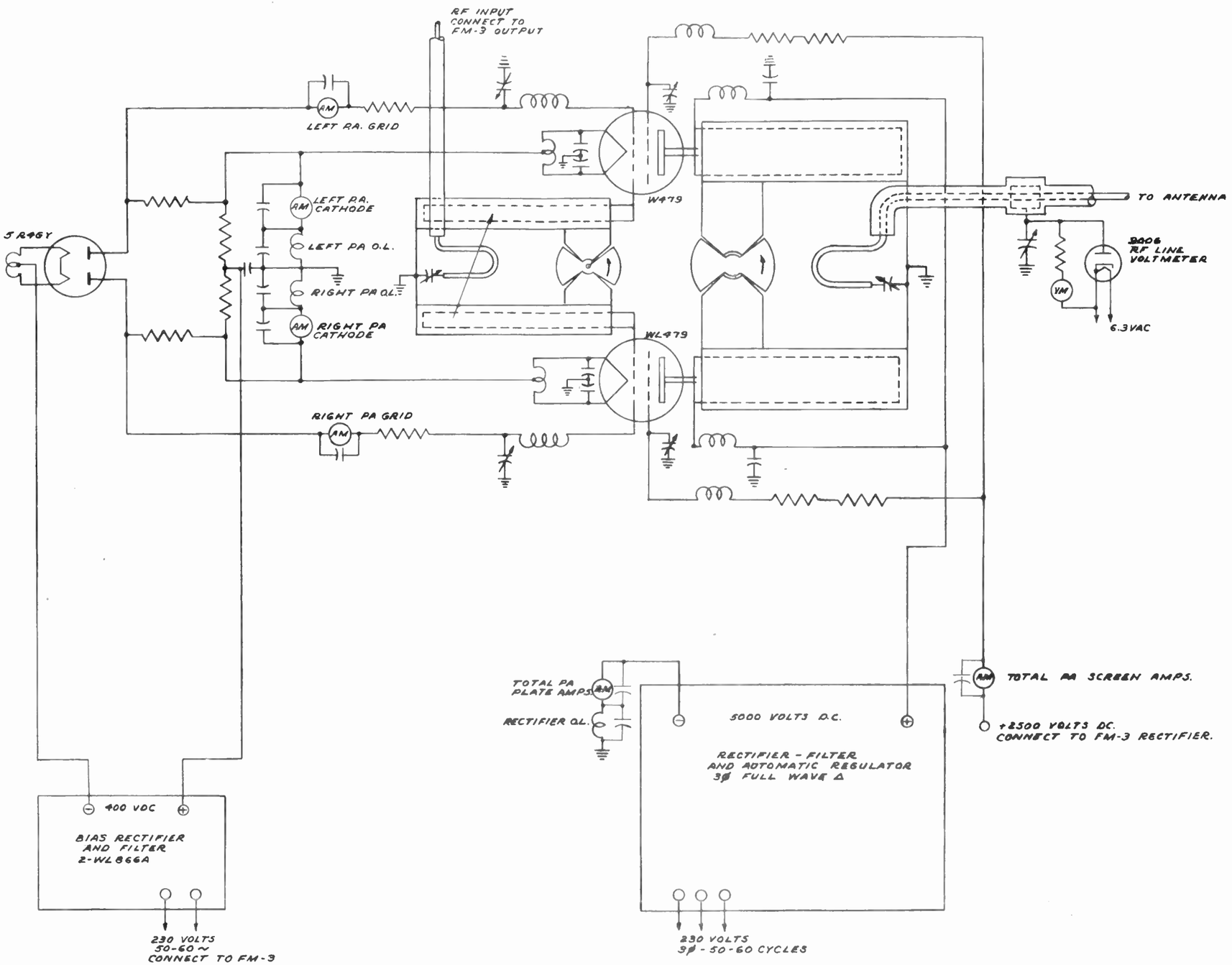
NOTE *1 - SUB BASE SUPPLIED FOR CONVENIENCE IN ALIGNMENT OF THREE CUBICLES. SUITABLE HOLES ARE PROVIDED IN ENDS OF EACH INDIVIDUAL BASE FOR INTER-CONNECTION CONDUIT. TRIM STRIP PROVIDES COVER FOR BASE JOINTS ON FRONT.

NOTE *2 - WHEN RECTIFIER IS LOCATED REMOTE FROM EXCITER & POWER AMPLIFIER, SUB BASE IS NOT USED & SIDE SHIELDS ARE SUPPLIED FOR RECTIFIER TO MAKE THIS CUBICLE SAME SIZE AS EXCITER AND POWER AMPLIFIER.
STANDARD HOLE PLUGS FIT CONDUIT HOLES IN BASES

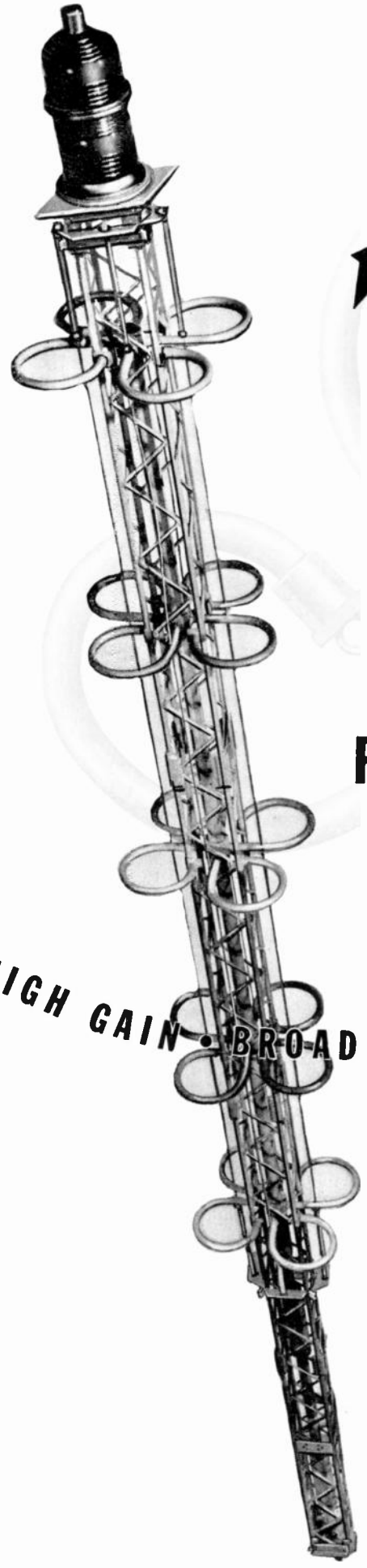


TOTAL MA SCREEN AMPS.

·2500 VOLTS DC.
'ONNECT TO FM-3 RECTIFIER.



FM-10 AMPLIFIER, SIMPLIFIED SCHEMATIC DIAGRAM
(Dwg. 7617112)



Western Electric

54A

CLOVER-LEAF

FM BROADCAST ANTENNA

- HIGH GAIN
- BROAD BAND
- HORIZONTALLY POLARIZED
- CIRCULAR AZIMUTH PATTERN
- 50 KW POWER CAPACITY

DEVELOPED BY BELL TELEPHONE LABORATORIES

The Western Electric 54A Antenna is designed to radiate horizontally polarized radio waves and to concentrate this radiated energy into a service area surrounding the transmitting station. It is engineered particularly for use by frequency modulation broadcast stations operating at carrier frequencies between 88 and 108 megacycles and at power levels up to and including 50 kilowatts.

The antenna comprises an array of two or more vertically stacked radiating units. Each radiating unit is composed of a cluster of four curved elements which in plan view forms a symmetrical shape similar to a four-leaf clover. A radio frequency voltage applied between the junction of the four elements and their ends causes in effect a ring of uniform current which produces a circular radiation pattern about the axis of the ring. By virtue of the directive properties of a vertical stack of such radiating units, much of the energy which would otherwise be radiated into outer space and accordingly lost for any useful purpose is diverted so as to add to the energy being transmitted into the station's service area. This conservation of the radiated energy permits the establishment of the station's required signal strength with radio transmitter powers of only one-fifth to one-half the amount otherwise needed. This reduction in the required transmitter power output is usually referred to conversely in the statement that the antenna has a power gain ranging from about two to about five depending on the size of the antenna (number of radiating units) selected. (See graph at top of opposite page). The antenna size selection is generally made on an economic as well as an engineering basis by the station owner and his engineering consultant.

The distribution of the radiated energy about a typical 54A Antenna of the five-unit size is shown at the bottom of the opposite page. It will be observed from this radiation pattern that the signal intensity is greatest in the direction of the horizon (0°) and is substantially less at higher elevations. With this type, as with all types of directive antennas, the radiation pattern becomes progressively broader and the gain less as the number of radiating units and length of the array is reduced. Conversely, the pattern becomes narrower and the gain higher as the number of units and length of the antenna are increased—*all providing that the instantaneous currents in the individual radiating units are established and maintained in their proper relationships.*

Maximum gain occurs when the instantaneous currents in all radiating elements are in time phase and of equal amplitude. These current relationships are easily and correctly established at the station's operating frequency with the 54A Antenna at the time of installation *by methods which do not require field or factory tuning.* All radiating elements are connected by means of simple clamps at half wavelength intervals to a 3-inch diameter feed conductor which is centrally located within the tower structure. The tower itself serves as the return or outer conductor of the feed line. The usual phase reversal occurring along such a feed line at half wavelength intervals is compensated for by merely reversing the mounting position of the radiating elements in adjacent units. This simple installation procedure assures the correct current phasing for maximum gain at the station's operating frequency.

These new design features of the 54A Antenna eliminate the need for multiple transmission lines, phase correcting lines or networks, balancing lines, etc., which are troublesome because their length must be adjusted for the operating frequency to avoid an error in antenna current relations with a corresponding compromise in antenna gain.

The predicted gain of the 54A Antenna is further assured by the use of four small diameter vertical cables to nullify vertically polarized radiation which might otherwise be radiated at high angles. This type of radiation is usually caused by spurious currents flowing in vertical structural members as the result of coupling between the structure and radiating elements.

The impedance of the 54A Antenna array is matched to the impedance of a coaxial transmission line by means of a unique low-loss transformer which utilizes the base section of the tower and antenna feed conductor. This transformer can be easily adjusted over a wide impedance range and it is set to the proper adjustment at the time of installation.

The one-foot square tower furnished as a part of the 54A Antenna is composed of an assembly of standardized structural steel welded sections. There is a base "B" section and from one to four identical length "A" sections, depending on the antenna gain selected. This tower structure has been conservatively designed and constructed by the Blaw-Knox Company to withstand high wind velocities and heavy icing loads. All steel parts of the antenna are "hot-dipped" galvanized to assure the maximum protection against corrosion.

Provisions are made for the installation of electric heating cables inside of the tubular radiating elements for sleet melting. Since one end of each radiating element is connected directly to the tower structure, the need for rf filters in the heater power circuit is avoided.

Provisions are also made for the mounting of a 300 mm aircraft warning beacon light on top of the tower structure, but the top plate may be drilled to mount any other beacon light selected. The heating units and beacon light are not necessarily required in all installations. Therefore, they are not furnished as a part of the antenna but may be ordered separately.

Antenna is designed for any power level up to and including 50 kilowatts.

Currents in this conductor assure maximum antenna gain by nullifying the vertically polarized energy which would otherwise be radiated from vertical structural members. Identical conductors are installed on each of the four sides of the tower.

No tuning of radiating elements or antenna array is required.

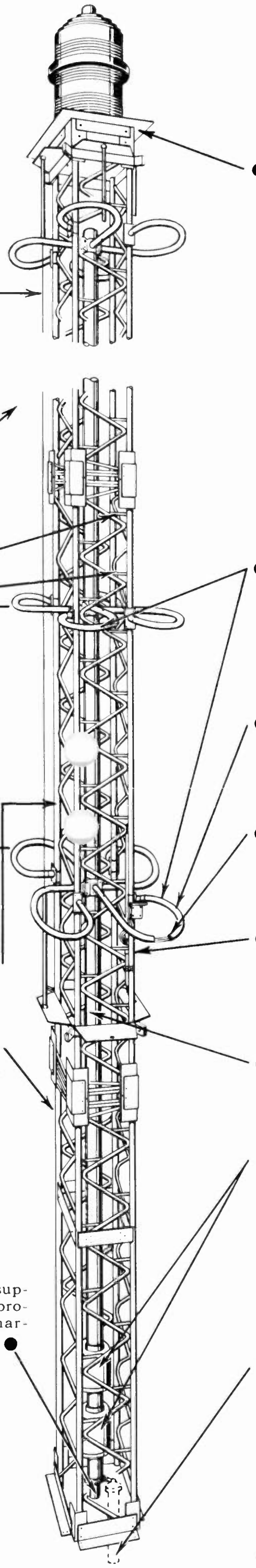
Climbing steps

Elements are clamped to tower ·ucture at half wavelength inter-.ls at time of installation. Spacing can be easily altered if frequency assignment is changed.

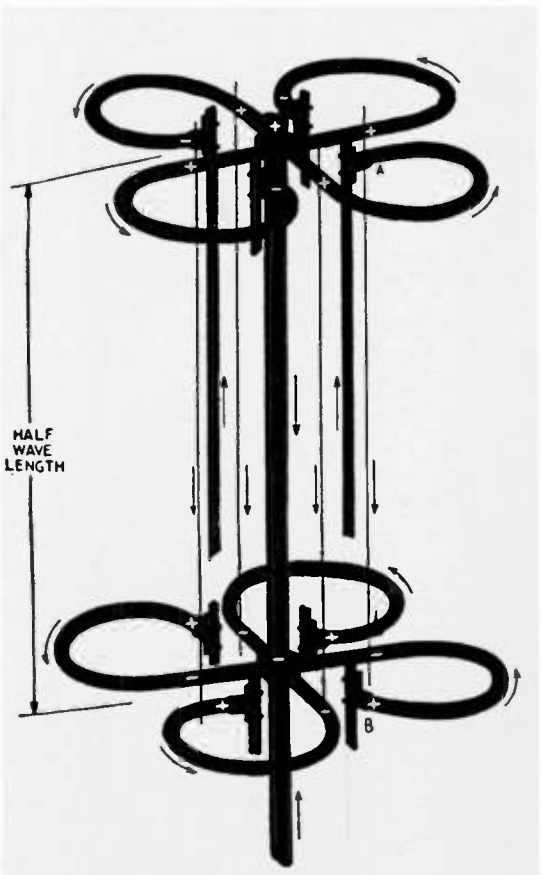
"A" tower sections.

Base "B" tower section.

Quarter-wave supporting stub, provides second harmonic filtering.



- Mounting for 300 MM. aircraft warning beacon.
- No rf insulators or dielectric materials are used. This minimizes maintenance and provides full protection against lightning surges.
- Structural steel tower sections furnished as part of the antenna are designed and constructed by *Blaw-Knox Company*.
- By simply reversing positions of elements in adjacent units the instantaneous current in all elements is brought into phase. Usual phasing networks and multiple feed lines are eliminated.
- All radiating elements in an antenna are identical and ir changeable.
- Radiating elements are desi for easy installation of electric heating units for sleet removal.
- Tower structure serves dual purpose of supporting radiating elements and acting as outer conductor of antenna feed line.
- All radiating elements are fed by this single center conductor.
- Two enlarged sections of center conductor provide a simple low loss transformer for matching impedance of antenna array to impedance of transmission line. This is adjusted by proper positioning of enlarged sections at time of installation.
- Only one coaxial transmission line required between transmitter and antenna.



ANTENNA ARRAY SCHEMATIC

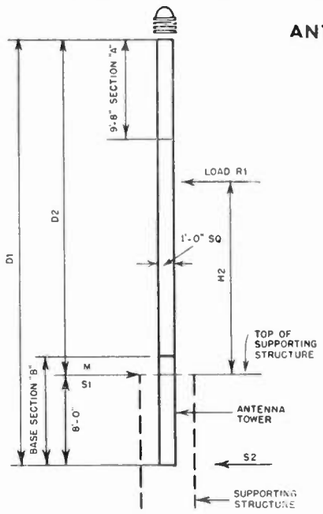
Arrows indicate instantaneous current relations in the radiating elements and feed line.

STRUCTURAL INFORMATION

THE 54A Antenna is comprised of one base "B" tower section and a minimum number of "A" tower sections in accordance with the following table:

Operating Frequency Megacycles	2-Unit	3-Unit	4-Unit	5-Unit	6-Unit	7-Unit	8-Unit
88-89	1	2	3*	3	4*	4	
89-90	1	2	3*	3	4*	4	
90-91	1	2	3*	3	4*	4	
91-92	1	2	3*	3	4*	4	
92-93	1	2*	2	3	4*	4	
93-94	1	2*	2	3*	3	4	
94-95	1	2*	2	3*	3	4*	4
95-96	1	2*	2	3*	3	4*	4
96-97	1	2*	2	3*	3	4*	4
97-98	1	2*	2	3*	3	4*	4
98-99	1	2*	2	3*	3	4*	4
99-100	1	2*	2	3*	3	4*	4
100-101	1	2*	2	3*	3	4*	4
101-102	1	2*	2	3*	3	4*	4
102-103	1	2*	2	3*	3	4*	4
103-104	1	2*	2	3*	3	4*	4
104-105	1	2*	2	3*	3	4*	4
105-106	1	2*	2	3*	3	4*	4
106-107	1	2*	2	3*	3	4*	4
107-108	1	2*	2	3*	3	4*	4

*Asterisk indicates that the required minimum number of "A" tower sections will permit the installation of an additional radiating unit.



ANTENNA LOAD DATA—moments include 300 mm beacon.

Supporting structures should be designed to withstand the bending moments given in the following table.

Number Of Sections A	Load R_1	D_1	D_2	H_2	Bending Moment At Top Of Supporting Structure—Ft. Lbs. M*	Reaction At Top Of Supporting Structure S_1	Reaction At Bottom Of Antenna Tower S_2
1	382#	20'-4"	12'-4"	7'-2½"	2757	727#	345#
2	645#	30'-0"	22'-0"	12'	7764	1616#	971#
3	909#	39'-8"	31'-8"	17'	15379	2831#	1922#
4	1174#	49'-4"	41'-4"	22'	25646	4380#	3206#

*These moments are given for the maximum (2) radiating units per "A" tower section. The reduction in moments for less than 2 radiating units per section is negligible.

DIMENSIONS

"A" tower section, 9′ 8″ by 1′ square.

"B" tower section, 10′ 8″ by 1′ square.

WEIGHT—Exclusive of beacon lights and conduits.

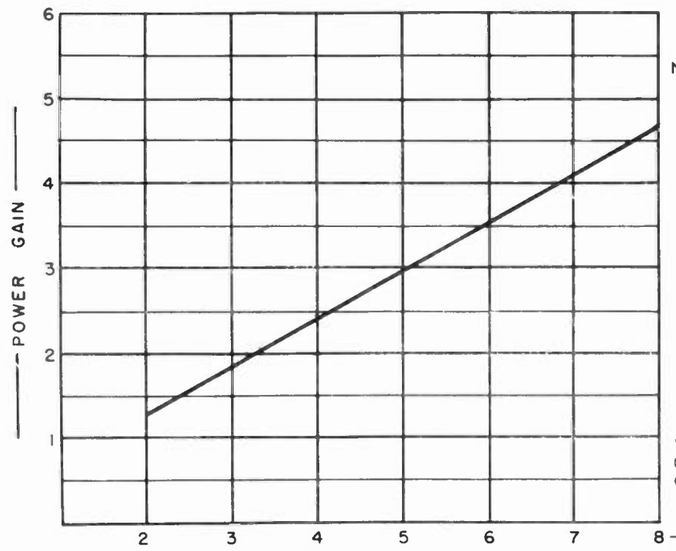
The weight of the antenna may be found by use of the following formula:

Weight (lbs.) = 500 + S(270) + N(70)

S = number of "A" tower sections

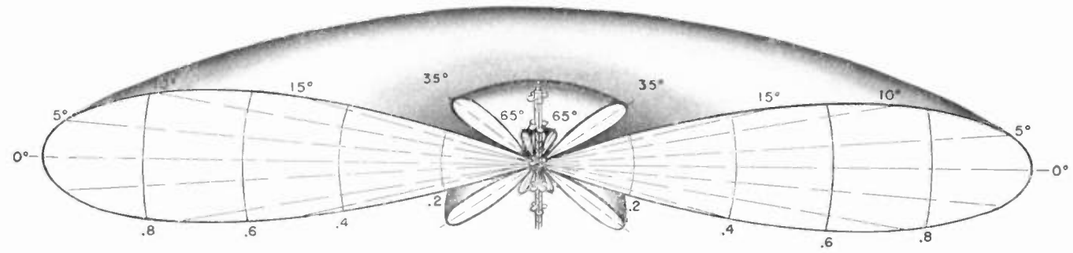
N = number of units

ANTENNA GAIN



NO. OF UNITS	COMPUTED GAIN* Power	Field	db
2	1.30	1.15	1.2
3	1.90	1.40	2.8
4	2.45	1.55	3.9
5	3.00	1.75	4.8
6	3.55	1.90	5.5
7	4.10	2.05	6.1
8	4.70	2.15	6.7

*Computed gain figures have been confirmed within 0.2 db by measurement on accurately scaled models. Gain referred to ½ wavelength dipole.



RADIATION PATTERN FOR A 5-UNIT ARRAY

Pattern measurements on accurately scaled models show that the distribution of energy in azimuth is circular (± O. 2. db), and that the computed beam width is realized in practice to ± 1°.

To Assist You...

The Bell Telephone Laboratories-Western Electric-Graybar team will be pleased to answer for you and your engineering advisor any specific equipment and installation questions. Some general questions and answers are listed below.

DESIGN AND PERFORMANCE

Q. What is the spacing between the radiating units along the 54A Antenna?

A. Half wavelength spacing is used. More units in the same over-all length antenna would add complexity without improvement in performance. Fewer units with full wavelength spacing could be used, but with some sacrifice in performance and only a minor cost reduction. For antennas of equivalent over-all length the sacrifice in antenna gain would be about 6 per cent. Furthermore, extraneous lobes radiated at high angles would be increased about 2 to 3 times in size while the main beam would become much narrower and accordingly more difficult to establish and maintain.

Q. What type of end-seal should be ordered for the 54A Antenna?

A. End-seals for 1⅝ and 3-1/8 inch transmission lines are available from Graybar and Northern Electric to fit exactly the mounting plate of the 54A Antenna. If a 6⅛ inch line is employed, a 3⅛ inch to 6⅛ inch reducing coupling is used in conjunction with the 3⅛ inch end-seal.

Q. Why were the performance measurements of the 54A Antenna made on small scale rather than full size models?

A. Measurements were made on accurate one-tenth scale models primarily because more complete and reliable antenna performance data can be obtained in this manner. The minimum distance required between the transmitting and receiving test antennas for accurate data is greatly reduced and the effects of reflections from the earth and elevated objects are practically nullified.

Q. If I should desire to increase the size of my 54A Antenna at some time after the initial installation, can I do so by adding more tower sections and radiating units?

A. Yes—providing you do not increase the size beyond seven or eight units and that the antenna supporting structure will accommodate a full size 54A Antenna.

Q. If desired, can I obtain a non-circular ground plane (azimuth) directional pattern?

A. Consideration is being given to methods of producing directivity in the azimuth plane. The Graybar or Northern Electric engineering representative will be pleased to receive your pattern requirements for engineering analysis.

INSTALLATION AND MAINTENANCE

Q. What type of supporting structure is required for the 54A Antenna?

A. Any structure of suitable mechanical strength and height to meet the requirements of the individual station may be used. The material used or its configuration will not affect the electrical performance of the antenna but the strength must be sufficient to support the weight and bending moments. Further assistance with the design and procurement of supporting structures is available through Graybar or the Northern Electric Company.

Q. Is the 54A Antenna assembled on the ground and installed as a unit on top of its supporting structure?

A. It can be partially assembled on the ground and then erected. Or it can be assembled in its place on top of the supporting structure. The choice of assembly method should be made by the erection contractor.

Q. Can the 54A Antenna be installed on top of a standard (AM) broadcast antenna structure?

A. Yes, if the AM antenna will carry the additional load safely. This question requires individual study in each case since the addition of the 54A Antenna will change the electrical characteristics of the modified structure as an AM antenna. Your engineering advisor is prepared to analyze the over-all problem and offer suitable recommendations. The engineering representative of the Graybar or Northern Electric Company will be pleased to assist with equipment engineering and procurement problems.

Q. Can the 54A Antenna safely be installed close to other FM or television antennas?

A. This question usually requires individual study. Any tall structure close to an antenna is likely to affect the radiation pattern and in the case of adjacent antennas serving separate stations, crosstalk problems usually arise which will require careful analysis by your engineering advisor. The Graybar or Northern Electric representative will be pleased to assist with equipment engineering and procurement problems.

Q. What line impedances will the antenna match?

A. Designed for impedance match with RMA standard sizes of 51.5 ohm transmission line, but this impedance value is not essential as design provides for match of line impedances between 50 to 100 ohms.

Q. Does the 54A Antenna require routine maintenance?

A. No maintenance is needed except that required by any elevated structure, such as occasional takeup at bolted joints, and repainting if the antenna is painted. Painting is not required for protection from the weather, but may be desired or, in some cases, required to make it more visible.

PROCUREMENT

Q. With whom do I place my order for a 54A Antenna?

A. There is a local distributor serving your territory whose experienced broadcast representative is prepared to assist you. See list of distributors on the back cover.

Q. What information pertinent to my station assignment should I supply with my order?

A. The following information is required: Assigned frequency, size of 54A Antenna (number of radiating units) desired, and required delivery date.

DISTRIBUTOR IN THE UNITED STATES

Graybar
ELECTRIC COMPANY

Executive Offices: 420 Lexington Avenue, New York 17, N. Y.

ALABAMA
Birmingham

ARIZONA
Phoenix

ARKANSAS
Little Rock

CALIFORNIA
Los Angeles
Oakland
Sacramento
San Diego
San Francisco

COLORADO
Denver

CONNECTICUT
Hartford
New Haven

DELAWARE
Wilmington

DIST. OF COLUMBIA
Washington

FLORIDA
Jacksonville
Miami
Orlando
Tampa

GEORGIA
Atlanta
Savannah

IDAHO
Boise

ILLINOIS
Chicago
Peoria

INDIANA
Evansville
Hammond
Indianapolis

IOWA
Davenport
Des Moines

KANSAS
Wichita

KENTUCKY
Louisville

LOUISIANA
New Orleans

MAINE
Portland

MARYLAND
Baltimore

MASSACHUSETTS
Boston
Springfield
Worcester

MICHIGAN
Detroit
Flint
Grand Rapids
Lansing

MINNESOTA
Duluth
Minneapolis
St. Paul

MISSISSIPPI
Jackson

MISSOURI
Kansas City
St. Louis

NEBRASKA
Omaha

NEW HAMPSHIRE
Manchester

NEW JERSEY
Newark

NEW YORK
Albany
Buffalo
New York
Rochester
Syracuse

NO. CAROLINA
Asheville
Charlotte
Durham
Winston-Salem

OHIO
Akron
Cincinnati
Cleveland
Columbus
Dayton
Toledo
Youngstown

OKLAHOMA
Oklahoma City
Tulsa*

OREGON
Portland

PENNSYLVANIA
Allentown
Harrisburg
Philadelphia
Pittsburgh
Reading

RHODE ISLAND
Providence

SO. CAROLINA
Columbia

TENNESSEE
Chattanooga
Knoxville
Memphis
Nashville

TEXAS
Amarillo
Beaumont
Corpus Christi
Dallas
Fort Worth
Houston
San Antonio

UTAH
Salt Lake City

VIRGINIA
Richmond
Roanoke
Norfolk

WASHINGTON
Seattle
Spokane
Tacoma

WISCONSIN
Milwaukee

*Sales Office

A NATIONAL ELECTRIC SERVICE

DISTRIBUTOR FOR CANADA AND NEWFOUNDLAND

Northern Electric
COMPANY LIMITED

General Offices: 1620 Notre Dame Street, W.

Plant: 1261 Shearer Street,
Montreal, P. Q., Canada

TWENTY-FOUR BRANCHES FROM COAST TO COAST

STRUCTURAL INFORMATION

THE 54A Antenna is comprised of one base "B" tower section and a minimum number of "A" tower sections in accordance with the following table:

Operating Frequency Megacycles	2-Unit	3-Unit	4-Unit	5-Unit	6-Unit	7-Unit	8-Unit
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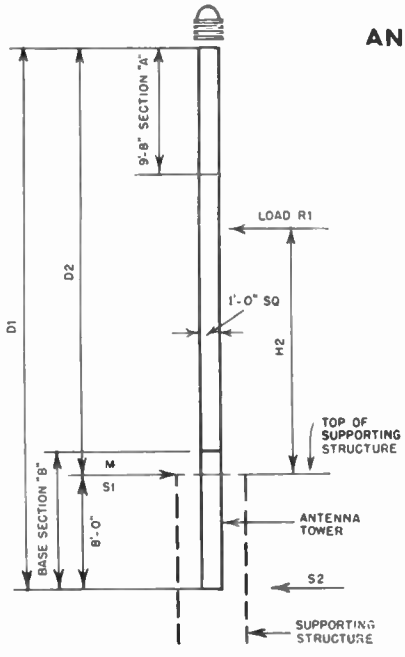

ANTENNA LOAD DATA—moments include 300 mm beacon.

Supporting structures should be designed to withstand the bending moments given in the following table.

Number Of Sections A	Load R_1	D_1	D_2	H_2	Bending Moment At Top Of Supporting Structure—Ft. Lbs. M*	Reaction At Top Of Supporting Structure S_1	Reaction At Bottom Of Antenna Tower S_2
1	382#	20'-4"	12'-4"	7'-2½"	2757	727#	345#
2	645#	30'-0"	22'-0"	12'	7764	1616#	971#
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4	1174#	49'-4"	41'-4"	22'	25646	4380#	3206#

*These moments are given for the maximum (2) radiating units per "A" tower section. The reduction in moments for less than 2 radiating units per section is negligible.

DIMENSIONS

"A" tower section, 9' 8" by 1' square.

"B" tower section, 10' 8" by 1' square.

WEIGHT—Exclusive of beacon lights and conduits.

The weight of the antenna may be found by use of the following formula:

Weight (lbs.) = 500 + S(270) + N(70)

S = number of "A" tower sections

N = number of units

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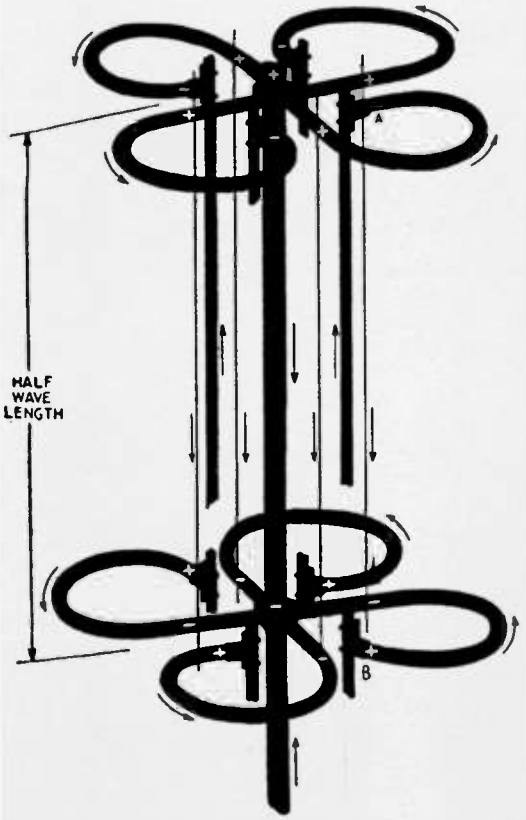

ANTENNA ARRAY SCHEMATIC

Arrows indicate instantaneous current relations in the radiating elements and feed line.

"A" tower sections.

Base "B" tower section.

Quarter-wave supporting stub, provides second harmonic filtering.

- Radiating elements are desig for easy installation of electric heating units for sleet removal.
- Tower structure serves dual purpose of supporting radiating elements and acting as outer conductor of antenna feed line.
- All radiating elements are fed by this single center conductor.
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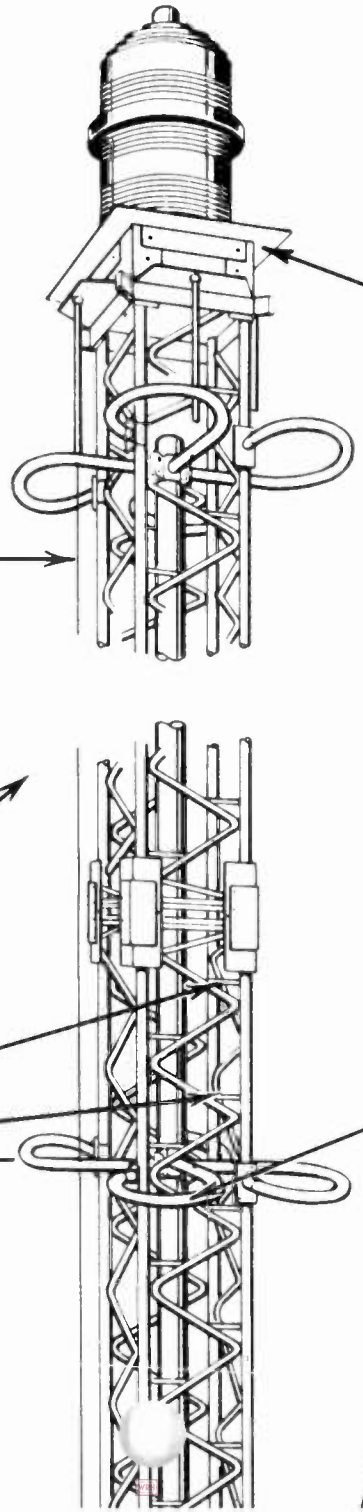
- Only one coaxial transmission line required between transmitter and antenna.



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No tuning of radiating elements or antenna array is required.

Climbing steps

Elements are clamped to tower structure at half wavelength intervals at time of installation. Spacing can be easily altered if frequency

Mounting for 300 MM. aircraft warning beacon.

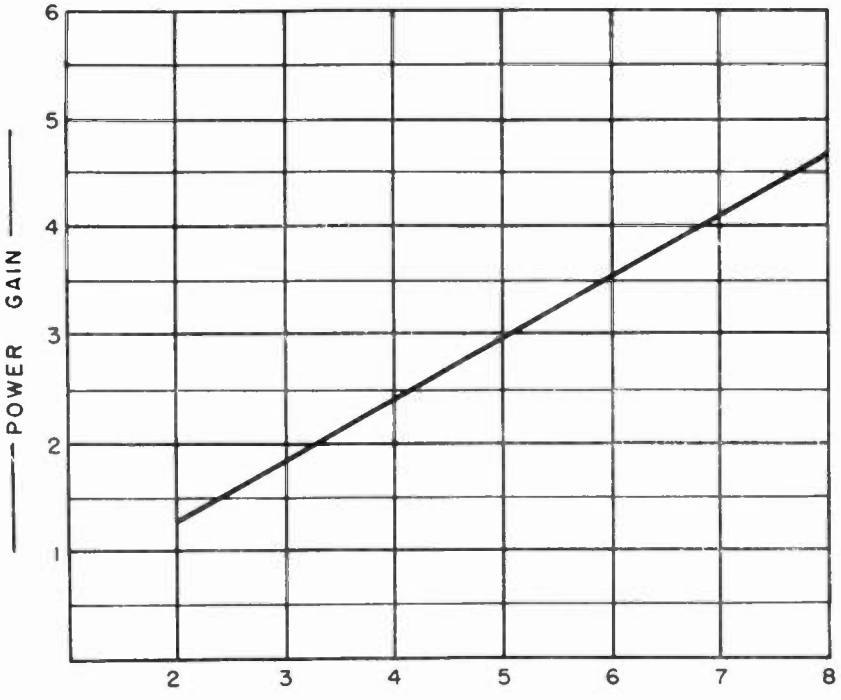
No rf insulators or dielectric materials are used. This minimizes maintenance and provides full protection against lightning surges.

Structural steel tower sections furnished as part of the antenna are designed and constructed by *Blaw-Knox Company*.

By simply reversing positions of elements in adjacent units the instantaneous current in all elements is brought into phase. Usual phasing networks and multiple feed lines are eliminated.

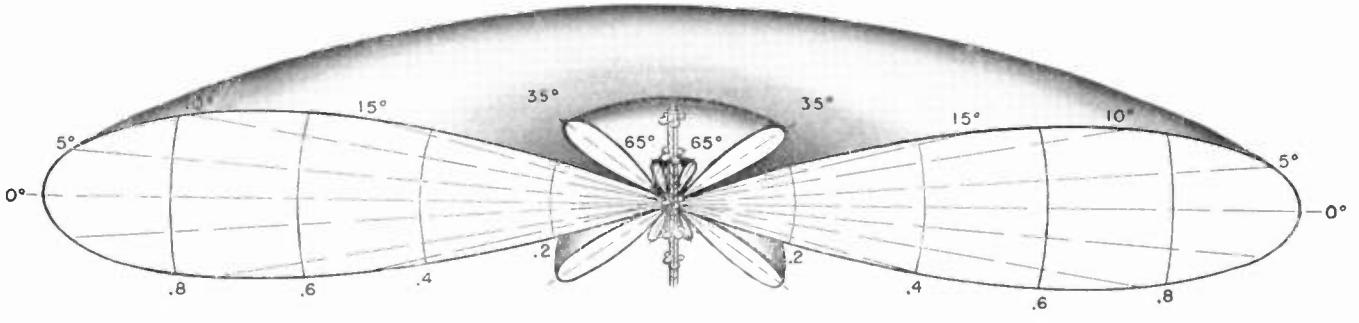
All radiating elements in an antenna are identical and interchangeable.

ANTENNA GAIN



NO. OF UNITS	COMPUTED GAIN* Power	Field	db
2	1.30	1.15	1.2
3	1.90	1.40	2.8
4	2.45	1.55	3.9
5	3.00	1.75	4.8
6	3.55	1.90	5.5
7	4.10	2.05	6.1
8	4.70	2.15	6.7

*Computed gain figures have been confirmed within 0.2 db by measurement on accurately scaled models. Gain referred to ½ wavelength dipole.



RADIATION PATTERN FOR A 5-UNIT ARRAY

Pattern measurements on accurately scaled models show that the distribution of energy in azimuth is circular (± O. 2. db), and that the computed beam width is realized in practice to ± 1°.

DESCRIPTIVE SPECIFICATION

Frequency Modulated

Transmitter Audio Equipment

R-1851

WESTINGHOUSE ELECTRIC CORPORATION
Industrial Electronics Division
September 1946

CONTENTS

FM TRANSMITTER AUDIO EQUIPMENT

The purpose of this specification is to suggest audio frequency and measurement facilities for use at the transmitter location of a frequency modulated broadcasting station. While this equipment has several interlocking points, for the sake of clarity and ease of use and reference it will be divided into two major sections, namely audio frequency facilities and measurement equipment.

It should be kept well in mind that the facilities as outlined are suggestions only and that each individual installation will vary in accordance with that station's particular needs. On account of this fact these specifications will be as general as possible while detailing all necessary equipment.

It has been assumed that this audio and measurement equipment will be used to program Westinghouse radio transmitters. However, as Westinghouse equipment is manufactured in accordance with RMA Standards and the RMA Engineering Department's proposed standard audio frequency input level of + 10 DBM $\pm$ 2 DB for 100% modulation of the radio frequency carrier is used, it may be assumed that these audio facilities can be used to feed any transmitter built to RMA Standards.

It has been further assumed that the program material will be transmitted from studio to transmitter location by means of land wire lines and that the distance traversed by these lines will introduce some loss in level. Whether accomplished by the station operators or by the local telephone company the equalization of these wire lines to eliminate frequency distortion will result in some further transmission loss. Mixing and switching systems at the transmitter site will also add to this loss. Microphones for local announcement and transcription turntables for local programming will be treated later.

Two basic equipment lists will be given. The purpose of the equipment listed under A is to supply the transmitter with sufficient audio frequency power to allow its carrier to be 100% modulated. Equipment to furnish audio frequency power for aurally monitoring the transmissions is included in this section. The equipment necessary to fill the basic measurement requirements of the F.C.C. is listed under B together with equipment recommended for station performance measurements.

The audio frequency equipment listed in this specification supplies full facilities for the complete operation of the Westinghouse Type MX Standard Transmitter Console (R-1776-B) and its use with this console will enhance the value of both units in operating convenience and utility.

A. AUDIO FREQUENCY FACILITIES

1. Program Amplification

A minimum of audio equipment to allow operation of a broadcast transmitter consists of a single amplifier, capable of delivering an output power of + 12 DBM and possessing sufficient gain to supply this output from a low level line. The input of this amplifier is connected to the incoming line, the output directly to the transmitter and the modulation meter used as an indicator while varying the amplifiers gain control to establish the proper modulation level. While entirely workable, such a setup, because of its inconvenience and lack of adaptability has little to recommend it. No interchange of inputs is possible without changing connections, presetting of audio levels without modulating the carrier is impossible. Even the smallest installations should be equipped with both a modest jack field and an audio volume indicator. By means of patch cords it is then possible to interchange telephone lines to the amplifiers input or to make a temporary connection from the incoming line direct to the transmitter in case of amplifier failure. The volume indicator allows the establishment of levels without the use of the transmitter and permits a continuous check of the audio levels being fed the transmitter.

The equipment tabulated by List 1 is suggested as the minimum of equipment to be supplied for program amplification purposes. Mounting facilities for program amplifiers, monitoring amplifiers and for measuring equipment are supplied by the Type 9-AX Cabinet Rack. The arrangement of the equipment in the rack is shown by Drawing 7822217. Seventy seven inches of vertical mounting space is obtained in a rack of this type and the space is allotted in such a manner that complete audio and measurement facilities are contained in this single rack. A full length rear door permits access to the individual units for inspection or maintenance. The Cabinet Rack is finished in Umber Grey and occupies a space 20-5/16 inches by 14-3/16 inches extending to a height of 82-7/8 inches.

Two Type 33 A" Jack Panels, each containing 24 pair of double jacks, mounted in a jack mat that conceals all raw and exposed edges are mounted just above the center of the racks mounting space. All inputs and outputs appear at these jacks and apparatus can be "patched" in or out of circuit as is found necessary or convenient. Jacks are Western Electric Type 218A. Three two foot patch cords with double plugs on each and are supplied for making temporary patches.

The volume indicator supplied consists of an industry standardized Weston Type 30 VU Meter mounted on a standard 5-1/4 inch rack panel. An attenuator located at the meters right allows the zero indication to be varied from + 4 to + 40 DB in 2 DB steps. A ten point selector switch is mounted on the left of the panel and may be wired to permit measurement of levels in

in up to 10 circuits without patching. It is suggested that this meter be connected directly into the line feeding the transmitter so as to continuously indicate the level at this point. To prevent error the meter should be available for measuring levels at other points only be patched connections.

A single Type BA3A Program Amplifier is capable of feeding the audio program to the transmitter and supplies enough gain (60 DB) to allow input levels of as low as -40 DB to be easily accommodated. The BA3A Amplifier matches input and output impedances of 600 ohms and will deliver a frequency response between 30 and 15000 cycles that is uniform to within plus or minus 1 DB. Well shielded audio and power transformers contribute to a hum level of -82 DB for + 30 DBM output. A step type interstage gain control is used to regulate the audio volume being furnished the transmitter. The amplifier mounts in a Type BR-2A Panel and Shelf Assembly.

Both audio and power terminal blocks are furnished. All wiring is shielded twisted pair, cabled a nd secured to the side of the rack.

LIST 1

PROGRAM AMPLIFICATION

	Item	Supplier's Number	Supplier	Am't.
1.	Cabinet Rack Type 9-AX	RCA-MI-4519E	RCA	1
2.	J Strips	RCA-MI-4537-D	RCA	2
3.	Audio Terminal Block	W.E. 100C	W.E.	1
4.	Terminal Block	Westinghouse S-122437	Westinghouse	1
5.	Jack Panel Type 33 AW	RCA-MI-4536A	RCA	2
6.	Jack Mat	RCA-MI-11502A	RCA	1
7.	Patch Cords	RCA-MI-4652-2A	RCA	3
8.	Volume Indicator	RCA-MI-11265	RCA	1
9.	Wire	WE-P-357170	W.E.	500'
10.	Panel & Shelf Assembly	RCA-MI -11598/11599	RCA	1
11.	Program Amplifier BA3A	RCA-MI-11224-B	RCA	1
12.	Tube Kit	RCA-MI-11266	RCA	1

(For Item 11 - Contains

1 - RCA 1622

2 - RCA 1620

1 - RCA 5Y3 GT/G)

2. LIMITING AMPLIFIER

The desirability of using a limiting amplifier in the input circuit of a frequency modulated transmitter has been the subject of considerable engineering and artistic discussion. Westinghouse Frequency Modulated Transmitters are capable of wide overswing without the introduction of an appreciable amount of harmonic distortion. However, an overall systems limitation is placed upon overswing by the FM Receiver discriminator. To avoid the possibility of transmitter overswing extending into the non-linear portion of the receivers ± 75 KC discriminator and thus introducing harmonic distortion in the receiver itself, it is recommended that a limiting amplifier be used in the transmitters input circuit. A limiting amplifier at this point further will assure the highest possible utilization of modulation capability without the danger of guard band violation.

The Type 86A1 Limiting Amplifier's design is such that a uniform frequency response and a remarkably low distortion is maintained with large compression ratios of the order of 18 DB. There are no audible "thumps" even though a large compression is suddenly applied. The pickup time of one millisecond restricts overmodulation surges and the return time is slow enough to prevent distorting low frequencies but fast enough to prevent noticeable level reduction after loud volume peaks. Push-pull stages are used throughout the amplifier. The power supply is built in and the hum and noise level is maintained at a low value through special transformer shielding. An output power of 1 watt (+ 30 VU) is provided with less than 0.75% total RMS distortion measured at 400 cycles with a compression of 18 DB. The distortion is lessthan 1.8% RMS when measured at any frequency between 50 and 7500 cycles. Step by step input and output volume controls are provided. A front panel meter is provided for indicating gain reduction and measuring plate currents and voltages. A total gain of 60 DB is available without compression and the frequency response is uniform within ± 2 DB from 30 to 15000 cycles at any gain control setting, with or without compression. A special door panel is provided to allow the meter to be adapted to a standard Type 36B Panel and Shelf Assembly. It is suggested that the amplifier be mounted as shown on Drawing 7822217.

LIST 1A

LIMITING AMPLIFIER

Item	Supplier's Number	Supplier	Am't.
1. Panel and Shelf Assembly Type 36B	RCA-MI-4682-H	RCA	1
2. Limiting Amplifier Type 86A1	RCA-MI-11216-C	RCA	1
3. Tube Kit	RCA-MI-11286	RCA	1
(For Item 2 - Contains 2 - RCA 6K7 1 - RCA 6N7 2 - RCA 1621 1 - RCA 6R7 1 - RCA 5T4)			
4. List 1			1

3. Announce and Program Accessories

It is sometimes convenient to be able to program a transmitting station from local sources. This is especially true of transmitters in isolated locations where interruptions of wire line service threaten in certain seasons or due to local conditions. It is often necessary to provide some means for the station operators to stage test programs or make station announcements from the transmitter site. Equipment suggested by List 1B will provide the required units for such facilities.

For making local announcements a Type 88A Pressure Microphone is suggested. This is a dynamic type microphone whose small size and rugged construction makes it ideal for the purpose. The output is essentially constant over the frequency range of 60 to 10000 cycles. It has a non-directional pickup characteristic and is finished in chromium and black. A desk mounting stand is supplied as the microphone support.

Temporary program service is made possible through the use of a single high quality Type 70C2 Transcription Turntable. Either vertical or lateral cut transcriptions can be reproduced and a filterswitch permits 4 playback curves for lateral and 2 playback curves for vertical recording systems. A polished diamond stylus allows the reppoduction of all frequencies from 50 to 10000 cycles and assures long life for both pickup and recordings. The transcription turntable is mounted in a floor mounting cabinet 25-1/4 inches wide and 24-1/4 inches deep. It stands to a height of 32-1/2 inches and is finished in a pleasing two tone grey with chromium trim. In cases where the high quality reproduction of the Type 70C2 Turntable is not desired or needed, a transcription turntable and reproducer which fits the left hand pedestal of a standard Type MX Transmitter Console Desk is available.

Both microphones and transcription reproducers are low level devices, the output of the microphone being approximately -60 DB and the Type 70C2 reproducer approximately -65 DB (0 = .001 watt). This output level is raised sufficiently for switching and mixing without degradation by the use of Type BA-2B Booster Amplifier. This high fidelity two stage unit supplies a gain of 50 DB at a uniform frequency response within $\pm$ 1.5 DB from 30 to 15000 cycles. It has its own self contained power supply and by the use of specially shielded audio and power transformers the noise and hum level is reduced to -70 DB at the rated output of + 2 VU. Two amplifiers provide individually for microphone and reproducer. Both of these amplifiers mount side by side on a single Type BR-2A Panel and Shelf Assembly.

LIST 1B

ANNOUNCE AND PROGRAM ACCESSORIES

Item	Supplier's Number	Supplier	Am't.
1. Pressure Microphone Type 88A	RCA MI-4048D	RCA	1
2. Announce Stand (Mounts Item 1)	RCA MI-4096	RCA	1
3. Transcription Turntable Type 70C2	RCA MI-4871-G	RCA	1
4. Booster Amplifier BA-2B	RCA MI-11226A	RCA	2
5. Tube Kit (For Item 4 Contains 2- RCA 1620 1- RCA 6X5 GT/G)	RCA MI-11287	RCA	2
6. Panel and Shelf Assembly B R-2A (Mounts Item 4)	RCA-MI-11598/11599	RCA	1
7. List 1			1

4. Line Equalization

Program circuits from studio to transmitters can roughly be placed in two categories. The first class are those that are leased from the local telephone company already equalized and guaranteed to deliver a certain frequency response. Nothing remains to be done with these lines except connect them to the proper input circuit. The second class are those unloaded, unequalized pairs that are sometimes available for program service. These lines must be equalized by the leasor and for equalizing such circuits up to ten miles in length to a frequency response within ± 1 DB from 30 to 15000 cycles a Type BE-1A Variable Line Equalizer is supplied. The BE-1A consists of a tuned equalizing circuit, isolating transformer, attenuator, 15000 cycle booster circuit and another isolating transformer. A switch is provided for putting the equalization in or out of circuit and a second switch selects the equalization up to 10000 or up to 15000 cycles. A 20 step attenuator is provided to adjust the output level. The equalizer occupies 5-3/16 inches of vertical rack space.

LIST 1C

Line Equalization

Item	Supplier's Number	Supplier	Am't.
1. Variable Line Equalizer BE-1A	RCA MI-4196	RCA	1

5. Monitoring Facilities

To permit aural monitoring of the program being broadcast, it is customary to employ a loudspeaker with its driving amplifier being fed from either the program source feeding the transmitter or from a detector circuit connected to the transmitters radio frequency output.

The loudspeaker suggested is the new Jensen Type RD Reproducer consisting of a satin finished walnut cabinet of bass reflex type containing a 15 inch Type "H" Articulated Coaxial Speaker Unit. The Type "H" Coaxial, with all Alnico 5 design, employs an H-F horn and L-F cone which are electrically and accoustically coordinated to achieve brilliant and natural reaponse throughout the entire useful frequency range. The frequency dividing network has variable control in the range above 4000 cycles. Nominal input impedance to the dividing network is 500 ohms, the maximum power handling capacity is 25 watts in speech and music systems.

Audio power for actuating this specker is supplied by a Type BA-4A Monitoring Amplifier mounted in a Type BR-2A Panel and Shelf Assembly. This amplifier will deliver 12 watts of audio power with a distortion of less than 3% total from 50 to

7500 cycles. A total matching gain of 105 DB is available with a frequency distortion of ± 2 DB from 30 to 15000 cycles. Both bridging and matching inputs are available. The power supply is self contained.

For muting the speaker when a microphone is opened for local announcements a relay and resistor combination are connected in the monitoring amplifiers output. An auxiliary contact on the console microphone key operates the relay transferring the amplifiers output to a fixed resistive lead. Power for the operation of this relay is obtained from the power supply for the console indicating lamps. The relay is mounted upon the Type BR-2A Panel and Shelf Assembly by means of a small angle type bracket.

When monitoring line transmission the monitoring amplifier is bridged directly to the line feeding the transmitter. For monitoring radio frequency transmissions the input of the amplifier is supplied from the Frequency and Modulation Monitor as explained in the Measuring Equipment Section of this specification.

Since the input and output circuits of the monitoring equipment appear at the jack field, temporary "patches" can be made to supply all monitoring needs.

LIST 2

Monitoring Facilities

Item	Supplier's Number	Supplier	Amount
1. Reproducer	Jensen RD-151	Jensen	1
2. Monitoring Amplifier BA-4A	RCA-MI-11223	RCA	1
3. Tube Kit (For Item 2 - Contains 2 - RCA 1620 2 - RCA 1622	RCA-MI-11267 1- RCA 6SN7 -GT 1- RCA 5U4-G)	RCA	1
4. Panel and Shelf Assembly BR-2A (Mounts Item 2)	RCA-MI-11598/11599	RCA	1
5. Relay Power Supply	RCA-MI-11303	RCA	1
6. Relay (Speaker muting relay)	W.E. E-127	W.E.	1
7. Relay Mounting Plate (Mounts Item 6)	W.E. 628A	W.E.	1
8. Resistor, 500 ohm 10 watt (Speaker Load)	Ohmite Brown Devil	Ohmite	1
9. List 1			1

B. MEASURING EQUIPMENT

1. Frequency and Modulation Meter

To supply frequency deviation and modulation percentage indication to meet the engineering requirements that are considered necessary and desirable in accordance with the F.C.C. "Manual of Good Engineering Practice" it is recommended that an REL Type 600R FM Broadcast Frequency and Modulation Monitor be used. This instrument contains its own power supply and occupies only 8-3/4 inches of vertical rack space. The recommended mounting position is shown by Drawing 7822217. The monitor can be furnished for any single frequency in the assigned frequency modulation broadcast spectrum and will indicate the average carrier frequency over a range of plus or minus 2000 cycles from the assigned transmitter center frequency with an accuracy of plus or minus 200 cycles with internal calibration. The modulation indication is direct reading to plus or minus 140% modulation based upon a plus or minus 75 KC transmitter swing as 100% modulation. The modulation indication includes the effect of pre-emphasis. This modulation indication has an accuracy of plus or minus 3% at 100% modulation and 5% at all other indications for steady modulation. An over modulation alarm circuit adjustable for modulation levels from 50 to 120% modulation is included.

The radio frequency input required is normally 10 volts in 50 ohms termination but may vary between a minimum of 8 volts and a maximum of 30 volts. The instrument operates from a power source of 115 volts, 60 cycles, single phase and consumes 90 watts.

A coupling amplifier furnishes an audio monitoring output of 0 DBM for plus or minus 75 KC swing at 1000 cycles. The frequency response is within plus or minus o.5 DB from 50 to 15000 cycles and the distortion is less than 0.5% RMS sum in a 600 ohm termination. 75 microsecond de-emphasis circuits are included. This audio output is fed to a Type 111C Repeating Coil for isolation purposes and the secondary of this coil is used for supplying audio for measurement and to operate the air check position of the audio monitoring system. The repeating coil is mounted on a 3-1/2 inch blank panel located directly beneath the monitor.

LIST 3

Frequency and Modulation Monitor

Item	Supplier's Number	Supplier	Am't.
1. Frequency and Modulation Monitor	REL 600R	REL	1
2. Vacuum Tube	RCA 7F8	RCA	6
3. Vacuum Tube	RCA 6AG7	RCA	1
4. Vacuum Tube	RCA 7A6	RCA	2
5. Vacuum Tube	RCA VR-105	RCA	1
6. Vacuum Tube	RCA 6Y6G	RCA	1
7. Vacuum Tube (Items 2 through 7 for Item 1)	RCA 5V4G	RCA	1
8. Repeating Coil	W.E. 111C	W.E.	1
9. Blank Panel (Item 9 mounts Item 8)	RCA MI-4591-B	RCA	1
10. List 1			1

2. Auxiliary Equipment

It is strongly recommended that all stations, regardless of power output or primary coverage, be equipped for making the basic measurements of frequency and harmonic distortion. Convenient and accurate instruments for this purpose are the General Radio Type 1932-A Distortion and Noise Meter with the input signal being furnished by the General Radio Type 1301-A Low Distortion Oscillator.

The Type 1932-A Distortion and Noise Meter is continuously adjustable over the audio frequency range and can be set to any frequency quickly, since it has only one main tuning control plus a small trimmer. The instrument consists of a high gain amplifier with an R-C interstage coupling unit which balances to a sharp null. The null frequency is controlled by a dial on the panel. Degeneration maintains a high stability of amplifier gain and also a flat transmission characteristic except within an octave of the null point. Also included are a vacuum tube voltmeter for reading the output of the system and a suitably calibrated attenuator for adjusting the sensitivity. Full scale deflection of the meter reads distortions of 0.3%, 1.0%, 3.0%, 10% or 30%. The range for carrier noise measurements extends to 80 DB below 100% modulation or 80 DB below an audio frequency signal of zero VU level. Distortion measurement frequencies extend from 50 to 15000 cycles and for noise and VU measurements from 30 to 45000 cycles. The accuracy of measurement of each distortion range is better than ± 5% of full scale ± 0.1% distortion. A vertical panel space of 7 inches is required for mounting and the instrument consumes 60 watts at 105-125 volts, 50-60 cycle power.

The Type 1301-A Low-Distortion Oscillator supplies audio frequency input signals for all types of measurements. It is a push button fixed frequency oscillator designed for this purpose and provides 27 fixed frequencies extending from 20 to 15000 cycles. It is AC operated and requires 7 inches of vertical rack space.

LIST 3A

Auxiliary Equipment

Item	Supplier's Number	Supplier	Am't.
1. Distortion and Noise Meter	GR-1932-A	G.R.	1
2. Oscillator	GR-1301-A	G.R.	1

SIMPLIFIED SCHEMATIC

TRANSMITTER AUDIO EQUIPMENT

EQUIPMENT IDENTIFICATION

DRAWING 7822218

1 & 2	- Preliminary Amplifiers	List 1B
3	- Line Equalizer	List 1C
4	- Keys	MX Console
5	- Mixing Attenuators	MX Console
6	- Program Amplifier	List 1
7	- Limiting Amplifier	List 1A
8	- Rack Volume Indicator	List 1
9	- Desk Volume Indicator	MX Console
10	- Bridging Coil	Optional
11	- Monitor Key	MX Console
12	- Monitor Amplifier	List 2
13	- Speaker Relay	List 2
14	- Speaker	List 2
15	- Modulation Monitor	List 3
16	- Audio Oscillator	List 3A
17	- Distortion & Noise Meter	List 3A
18	- Master Attenuator	MX Console
20	- Jack Field	List 1

BLANK PANELS

If for any reason all the equipment shown mounted in the rack by Drawing 7822217 is not procured, the spaces allocated to the equipment may be covered by blank panels to preserve the appearance of the cabinet. The following blank panels exactly replace the tabulated equipments.

Blank Panel 8-23/32" RCA-MI-4594-B replaces

Type 600 R Frequency and Modulation Monitor
Type 36-B Panel and Shelf Assembly
Type BR-2A Panel and Shelf Assembly

Blank Panel 5-7/32" RCA-MI-4592-B replaces

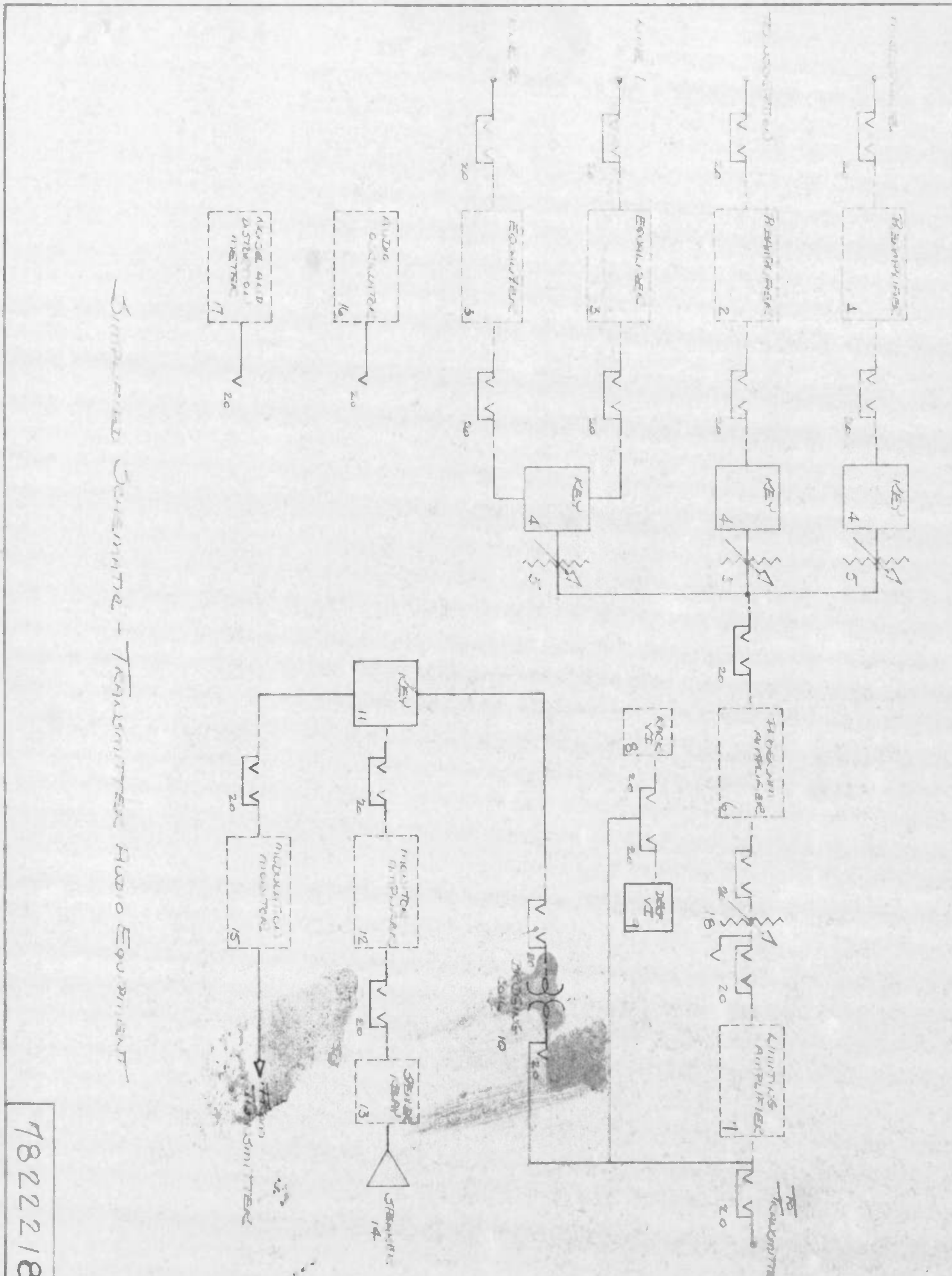
Type BE-1A Equalizer
Volume Indicator

Blank Panel 6-31/32" RCA-MI-4593-A replaces

GR Type 1932 A Distortion and Noise Meter
GR Type 1301 A Oscillator

WESTINGHOUSE FORM 244" B

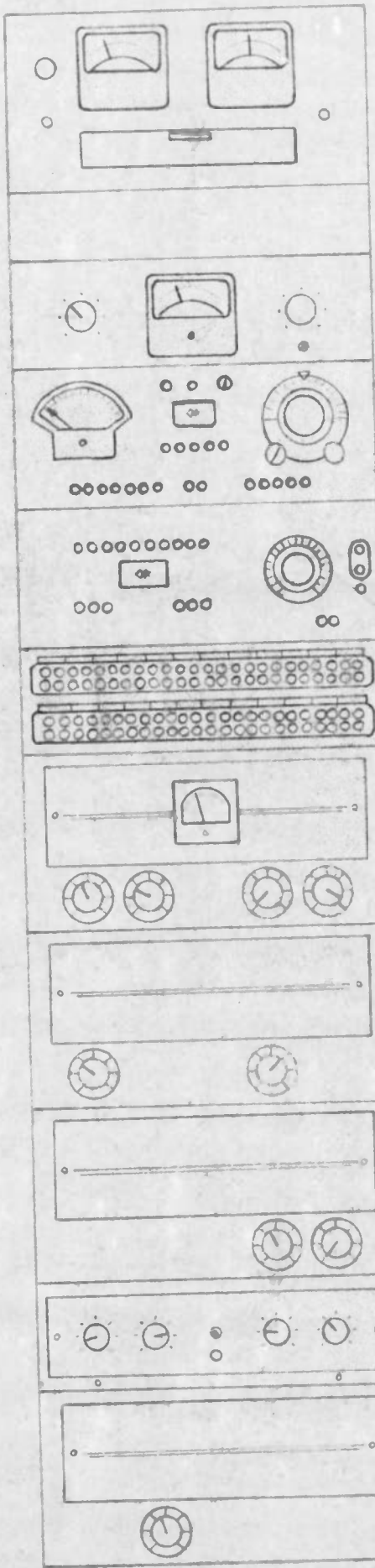
Cut on this line for filing with letter size 8½" x 11"



WESTINGHOUSE ELECTRIC CORPORATION

INDUSTRIAL ELECTRONICS DIVISION

BALTIMORE, MD.



FREQUENCY & MODULATION MONITOR

BLANK PANEL

VOLUME INDICATOR

DISTORTION & NOISE METER

OSCILLATOR

JACK FIELD

LIMITING AMPLIFIER

PRELIMINARY AMPLIFIERS

PROGRAM AMPLIFIER

EQUALIZER

MONITORING AMPLIFIER

TRANSMITTER AUDIO EQUIPMENT

7822217

PERFORMANCE SPECIFICATIONS FOR

REL MODEL 600-R FM MONITOR

Operating Frequency	- Any Single Frequency in the assigned FM Broadcast Spectrum.
Frequency Indication	- Average carrier frequency over a range of plus or minus 2000 cycles from assigned transmitter center frequency.
Accuracy of Frequency Indication	- Plus or minus 200 cycles with internal calibration. Well within FCC tolerance of plus or minus 1000 cycles for prolonged operating periods.
Modulation Indication	- Direct reading to plus or minus 140% modulation on basis of plus or minus 75 kc. transmitter swing being 100%. Indication includes effect of pre-emphasis. Indication on program is of speed and ballistic characteristics to conform with industry and FCC standards of modulation monitors.
Accuracy of Modulation Indication	- Plus or minus 3% at 100% modulation, plus or minus 5% at all other indications for steady modulation. Special mark provided to indicate plus or minus 133-1/3% modulation (plus or minus 100 kc. swing) for transmitter measurement purposes.
Over Modulation Alarm	- Signal lamp and free make contacts for remote indication. Alarm threshold adjustable from 50 to 120% modulation, either polarity.
Remote Indication Facilities	- Modulation, center frequency, and over-modulation alarm may be indicated remotely.
Audio Monitor	- Coupling amplifier with output of 0 dbm for plus or minus 75 kc. swing at 100 cycles. Includes 75 microsecond de-emphasis. Frequency response within plus or minus 1/2 db from 50 to 15000 cycles, and distortion less than 1/2% RMS sum, with 600 ohm termination.
RF Input	- Normal 10 volts RMS, minimum 8 volts, maximum 30 volts, in 50 ohm termination. Standard coaxial fittings provided. Accidental inputs as high as 25 watts will not damage the instrument.

Primary Power	- 115 volts, 60 cycles, single phase, 90 watts. Supply stabilized for plus or minus 12% line voltage changes.
Ambient Temperature Range	- Plus 10 to plus 40 degrees Centigrade.
Tube Complement	- 6 type 7F8, 1 type 6AG7, 2 type 7A6, 1 type VR105, 1 type 6Y6G, 1 type 5V4G.

TREAT YOUR TRANSMITTER to

- *Greater Operating Convenience*
- *Efficient Mixing and Switching Facilities*
- *Quicker, Lower Cost Changes and Additions*

WESTINGHOUSE

Desk Type

STANDARD TRANSMITTER

CONSOLE

WESTINGHOUSE ELECTRIC CORPORATION

INDUSTRIAL ELECTRONICS DIVISION • BALTIMORE, MARYLAND

Descriptive Specification R-1766-C

Descriptive Specification R-1766-C

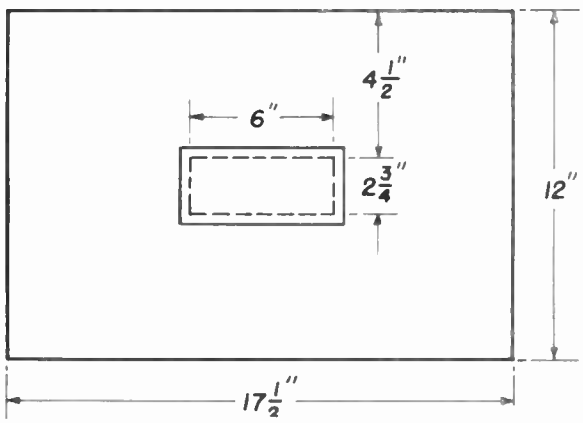
WESTINGHOUSE DESK TYPE STANDARD TRANSMITTER CONSOLE

The Standard Transmitter Console is supplied only as described in the following pages except:

A. The purchaser may have either one or both of the two outside panels drilled and engraved to his specifications at no extra cost. In this case accurate layouts for this work should be supplied.

B. The purchaser may have one or both of the two outside panels modified to contain special equipment as desired. The material and labor cost of this work is to be borne by the customer with the exception of drilling and engraving which will be done on a no charge basis.

In no case will any changes be made to the center panel.



Plan View of the Side Panels

In many instances the special equipment may be mounted in the patch plate shown. This method of mounting keeps the appearance of the console balanced especially when small items are to be mounted on only one panel. When the quantity or size of the equipment is such that it cannot be mounted in this manner the panel is supplied less cutout and plate.

The Westinghouse Standard Transmitter Console is an attractive desk type console containing mixing and switching facilities required at the Transmitter. It allows for future changes and additions with a minimum of effort and expense. Its appearance, operating convenience and dependability make the console a desirable addition to any Transmitter.

Desk—See attached photo

Dimensions

Width—65 25 32"

Depth—35 7/8"

Height 30 1/2"

Right hand drawer inside size

Width 13 9 16"

Depth 24 1/8"

Height 5 27 32"

Left hand compartment

Width 19 1/4"

Depth 35"

Height 18"

The desk is of all metal construction with a top covering of black linoleum. The left hand pedestal contains a Stowe-Davis mechanism on which a typewriter may be mounted, or if desired, a 16" turntable may be housed in this space. The right hand pedestal contains three convenient drawers. A fourth drawer is located in the center between the pedestals. These drawers use E-Z slide suspension. A lock in the center drawer also locks the drawers in the pedestal. All wiring is concealed and large inspection panels to provide quick and easy access to the connector blocks are included. Skirts below the pedestals conceal the wiring conduits. Full rounded corners give a modern and pleasing appearance to the entire assembly.

Operating Console

Width—Same as desk

Height—12"

Center Panel size 23" x 12"

Side Panels—17 1/2" x 12"

The operating console is mounted at the rear and extends the width of the desk. All corners are rounded so as to harmonize with the desk, and give a pleasing appearance. Three panels are provided. The outside panels are left blank and provide space for future additions. All panels are hinged at the bottom to provide quick access from the front. The center control panel is slightly larger than the other two and contains the transmitter operating controls. Provisions have been made to permanently mount the station call letters at the center of this panel.

Center Control Panel—Plate 2

Switches

Transmitter Filament
Transmitter Main Rectifier
Local Microphone
Local Phono
Studio Line Change over and neutral
Moniter Off-Air-Line
Two Auxiliary Spare

Indicator Lamps

Transmitter Filament
Main Rectifier Ready
Main Rectifier On
Three Lamps across primary power
Local Microphone On
Local Phone On
Studio line 1 On
Studio line 2 On
Monitor "Air"
Monitor "Line"

Meters

Frequency Deviation Extension Meter
Modulation Percentage Extension Meter
Volume Indicator

Controls

Local Microphone
Local Phono
Master
Studio Line
Volume Indicator Attenuator
Monitor Level

Microphone Connector

1—Male plug supplied (Amphenol 91-MC3M)

Audio and Control Circuit—Plate 1

Balanced high quality attenuators are used throughout. The circuit is arranged so that the local microphone and local turntable cannot modulate the Transmitter when either of the studio lines are in use. Means are provided to cut out the monitor when the local microphone is in use. Mixing of the local microphone and local phono is provided. A Master Transmitter control and a Monitor Amplifier control are provided.

Indicator lamps show at a glance the position of switches and circuits in use. An external 12 volt well filtered direct current source with a capacity of 1 ampere is necessary to operate the indicator lamps associated with the audio control circuits. A commercial power supply such as RCA type MI-11303 or equivalent is recommended.

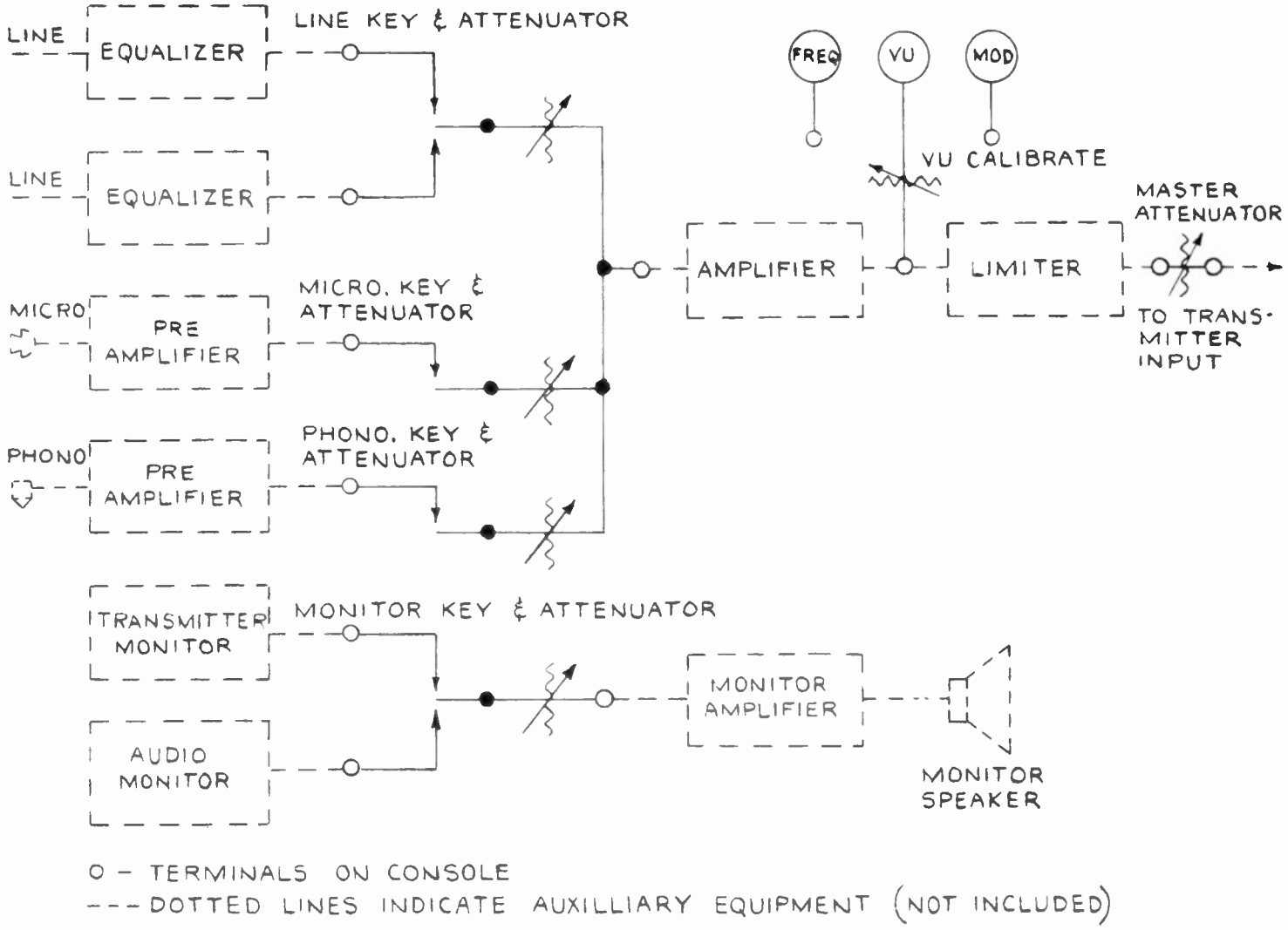
Chair

The chair is of all metal construction, mounted on rollers. It is upholstered in black and styled in keeping with the appearance of the desk.

Special Equipment

Since it is not possible to anticipate the requirements of each installation, the Standard Console is designed to permit the incorporation of additional apparatus. Extra equipment desired by the purchaser may be obtained on special order and installed in the space provided by the two seventeen and a half by twelve inch blank panels. In this way a console may be made to order containing special equipment. It is also possible to supply the two seventeen and a half by twelve inch panels engraved to the purchasers specific requirements without supplying added equipment or wiring. In this case accurate layouts for the two blank panels should be supplied. When ordering, a list of special equipment wanted should be submitted, and if possible the desired panel layout should be included.

STANDARD TRANS. CONSOLE
SIMPLIFIED LINE DIAGRAM



STANDARD TRANS. CONSOLE
ARRANGEMENT OF CENTER PANEL

STANDARD TRANSMITTER CONTROL CONSOLE

DESCRIPTIVE SPECIFICATION

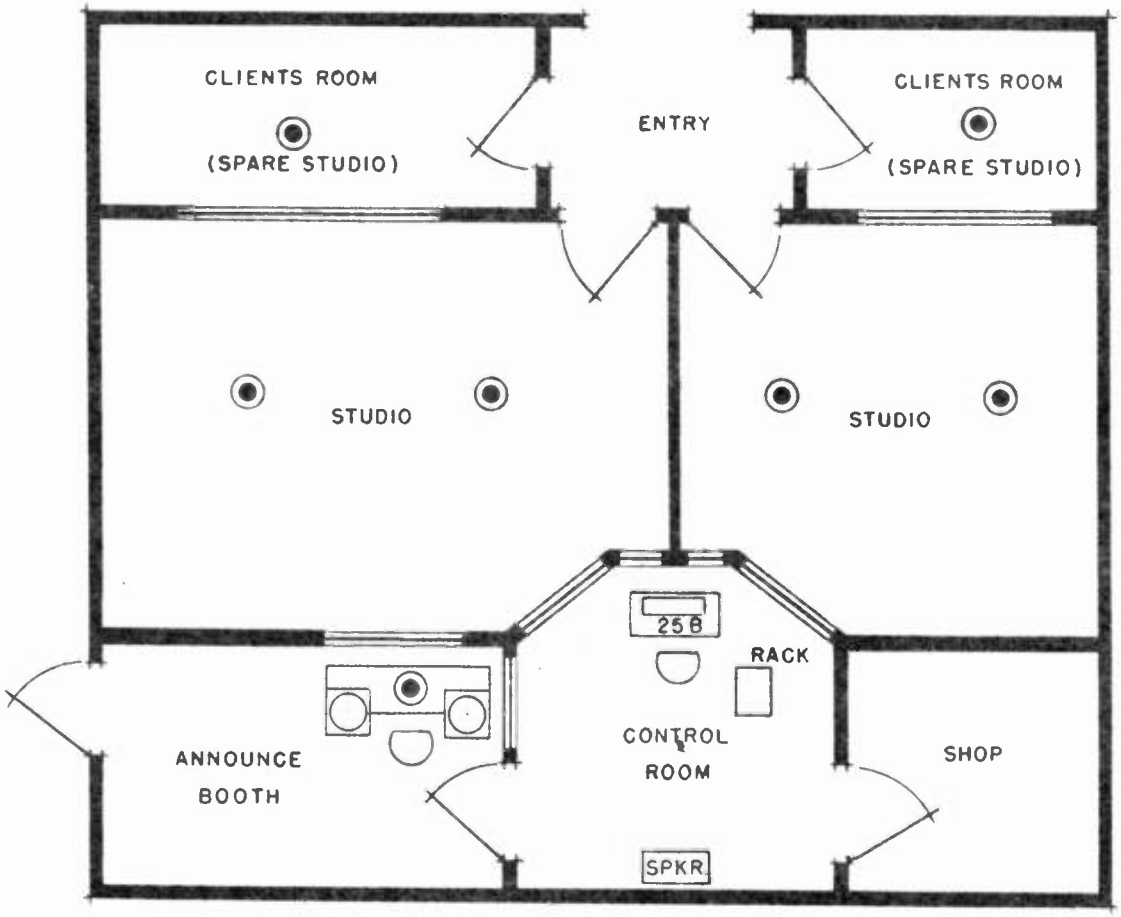
STUDIO AUDIO FREQUENCY EQUIPMENT

R-1775

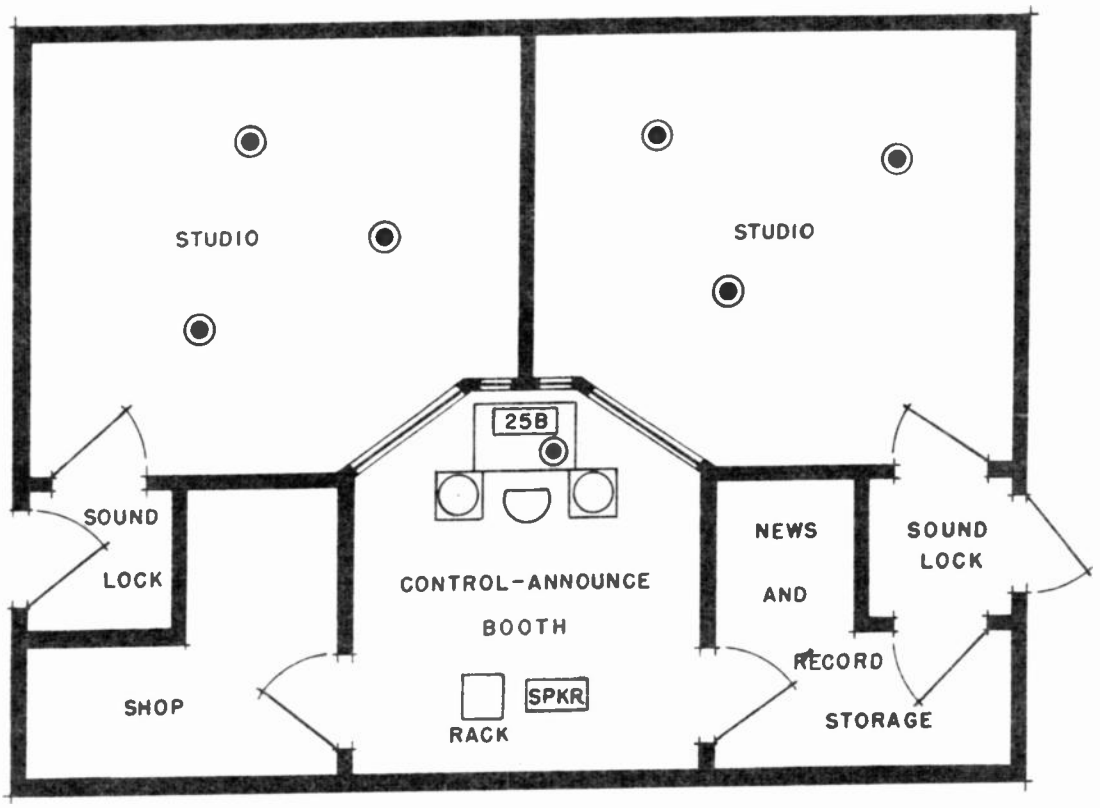
WESTINGHOUSE ELECTRIC CORPORATION

INDUSTRIAL ELECTRONICS DIVISION

June 1946

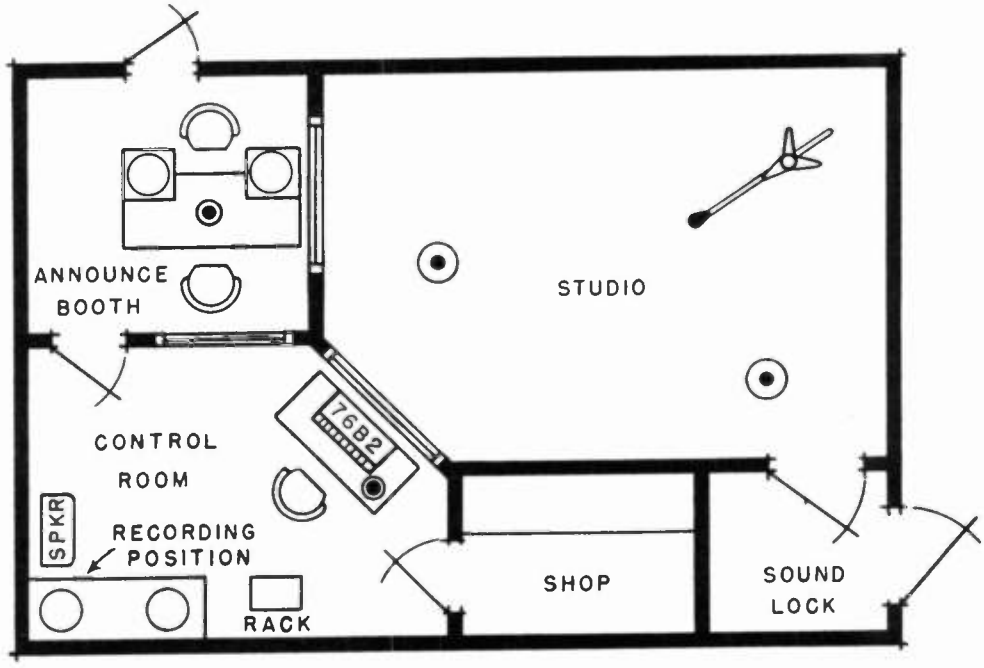


PROPOSED STUDIO LAYOUT



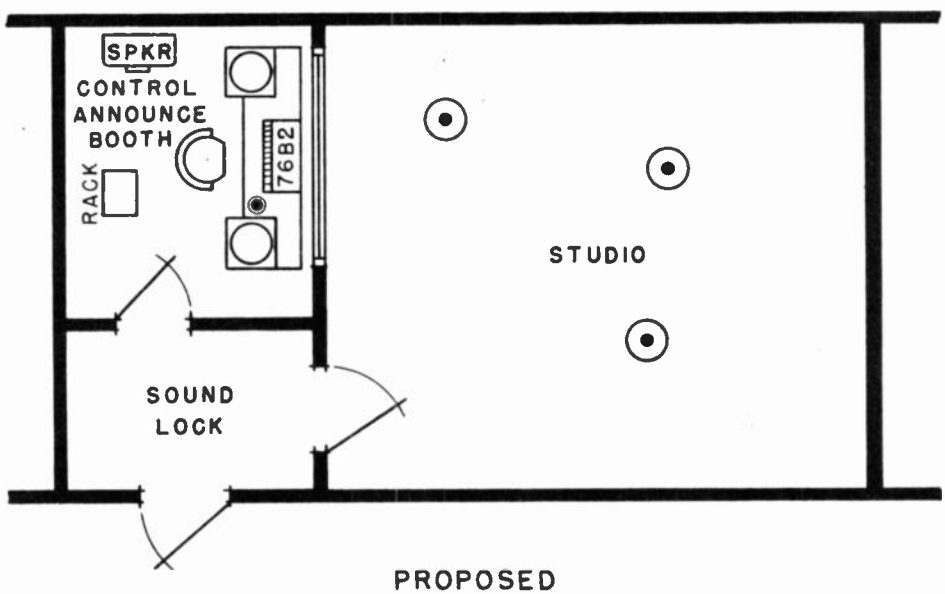
PROPOSED STUDIO LAYOUT

7423841



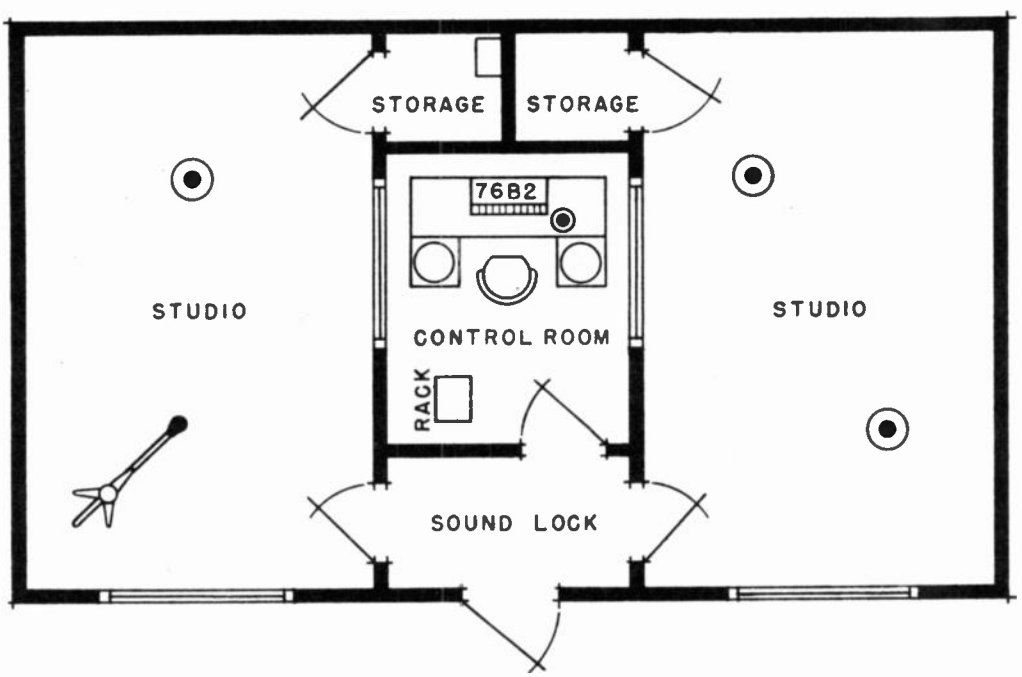
PROPOSED
STUDIO LAYOUT

7423269



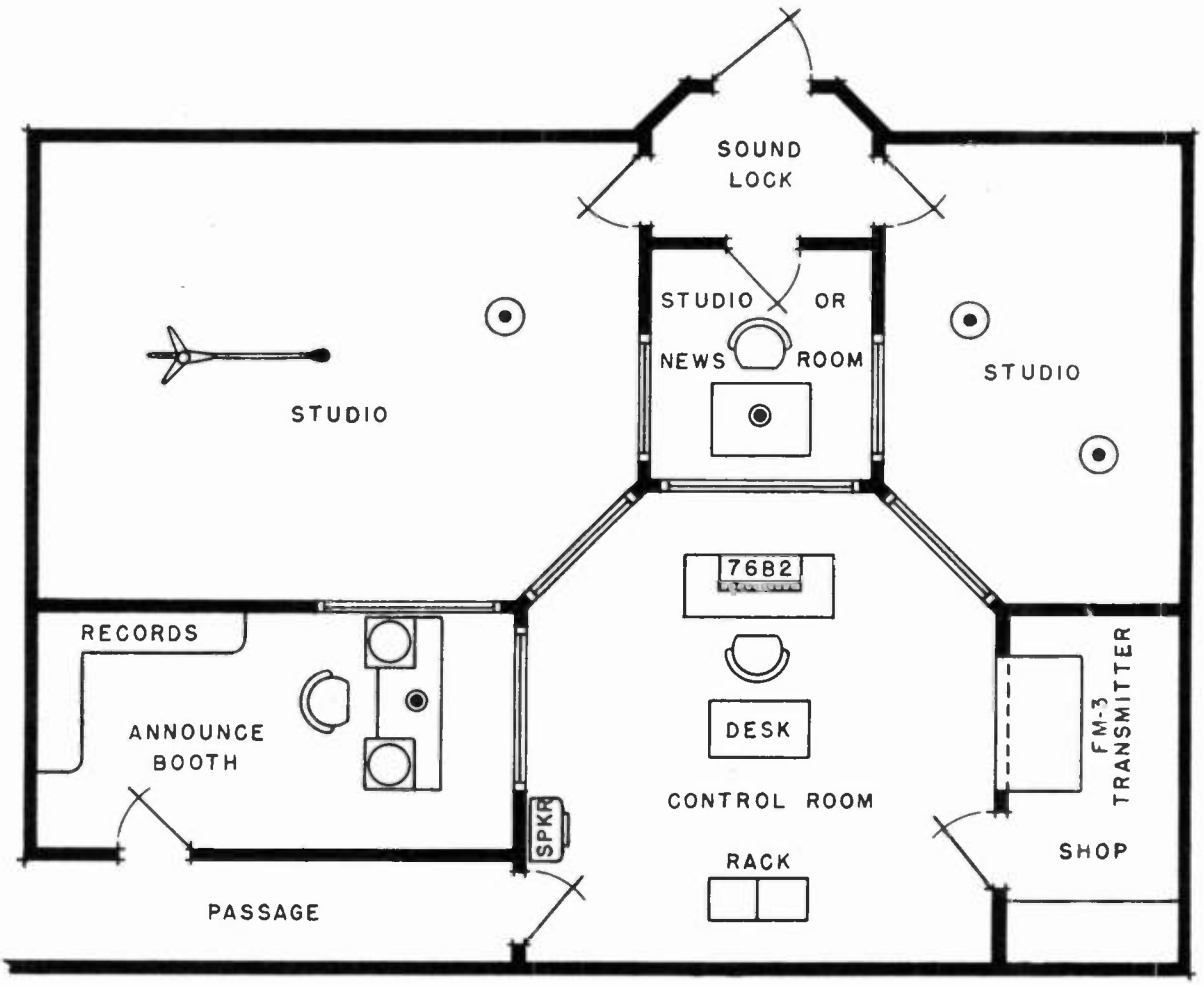
PROPOSED
STUDIO LAYOUT

7423270



PROPOSED
STUDIO LAYOUT

7423271



PROPOSED
STUDIO LAYOUT

7423272

CONTENTS

Studio Audio Frequency Facilities

List 1

Basic Audio Equipment

The minimum audio frequency studio facilities recommended for the establishment of a radio broadcasting studio is contained in List 1. This list provides materials for a single talent studio with three microphones and an announce booth with one microphone. Both the studio and the announce booth are provided with loud speakers electrically interlocked with the microphones for cue or talkback purposes. The control room is provided with monitoring loud speaker and a microphone for either talkback to studio or announce booth or for local announcements. Two 70-C2 Transcription Turntables are provided. The transcription turntables may be located in either the control room or the announce booth. Facilities for amplifying, control and switching of program material are furnished by a Type 76-B2 Consolette. A full description of the 76-B2 Consolette is furnished under the descriptive specifications covering this unit.

Three microphones are furnished for use in the studio. Two of these microphones are Type 77-D and the third Type 44-BX. The Type 77-D microphones have been selected because of their continuously variable directional characteristic and smooth frequency response. A variety of non-directional, uni-directional, and bi-directional characteristic patterns may be obtained by operating a screwdriver adjustment located on the back of the 77-D microphone. The Type 44-BX is well suited for high quality studio work and has the familiar "Figure Eight" type of pickup

pattern. Two adjustable floor stands and a boom stand are supplied for supporting the microphones. A wall mounting loudspeaker is supplied for cue and talkback purposes. This loudspeaker is electrically interlocked with the microphone keys to prevent acoustical feedback caused by live microphones and monitoring speaker in the same studio.

The announce booth is equipped with a single Type 88A Pressure Microphone mounted on an announce stand and a wall mounted speaker. The loudspeaker is interlocked for cue and talkback purposes.

A type 76-B2 Consolette is mounted on a desk or table in the control room. The power supply for the 76-B2 is wall mounted and may be placed in any convenient position. A Type 64-B floor console loudspeaker is furnished and should be positioned to enable unobstructed monitoring of all programs. A Type 88A pressure microphone mounted on an announce stand is used both for talkback to studios and for making local announcements. Two Type 70-C2 Transcription Turntables provide transcription reproduction at either 33-1/3 or 78 R.P.M. speeds. Either lateral or vertical cut transcriptions can be reproduced. Proper frequency compensation for all standard recording systems may be inserted into the circuit by means of a six position filter switch. To secure preamplification two self powered Type BA-2A booster amplifiers are mounted within the turntable bases. The turntables may be installed either in the control room or in the announce booth.

Up to six remote pickup lines pre-equalized by the local telephone company may be terminated directly to the consolette. They are selected by means of push keys on the front panel of the Consolette. Suggested additional equipment for jack panel and line input equipment will be found under List 1A.

A 600 to 600 ohm 6 db loss pad is furnished and should be connected between the consolette line output and the telephone line to furnish a stabilized impedance load for the program amplifier. This pad can be mounted beside the outgoing line terminal strip on the Consolette sub base.

Microphone plugs and wall receptacles are furnished. One thousand feet of shielded twisted pair wire is supplied for making all audio connections. Power wiring and conduit, junction and outlet boxes are to be furnished by the customer.

Drawings 7423273 and 7423270 show a typical studio layout based upon the equipment furnished by List 1.

Tube complements of tube kits listed are:

Tube Kit MI-11252 (76B2 Consolette)

11 - RCA 1620

2 - RCA 1621

2 - RCA 1622

1 - RCA 5U4G

1 - RCA 5Y4G

Tube Kit MI-11287 (BA-2A Amplifier)

2 - RCA 1620

1 - RCA 6X5GT/G

Bill of Materials for List 1

Drawing List

7423270
7423273

BILL OF MATERIALS

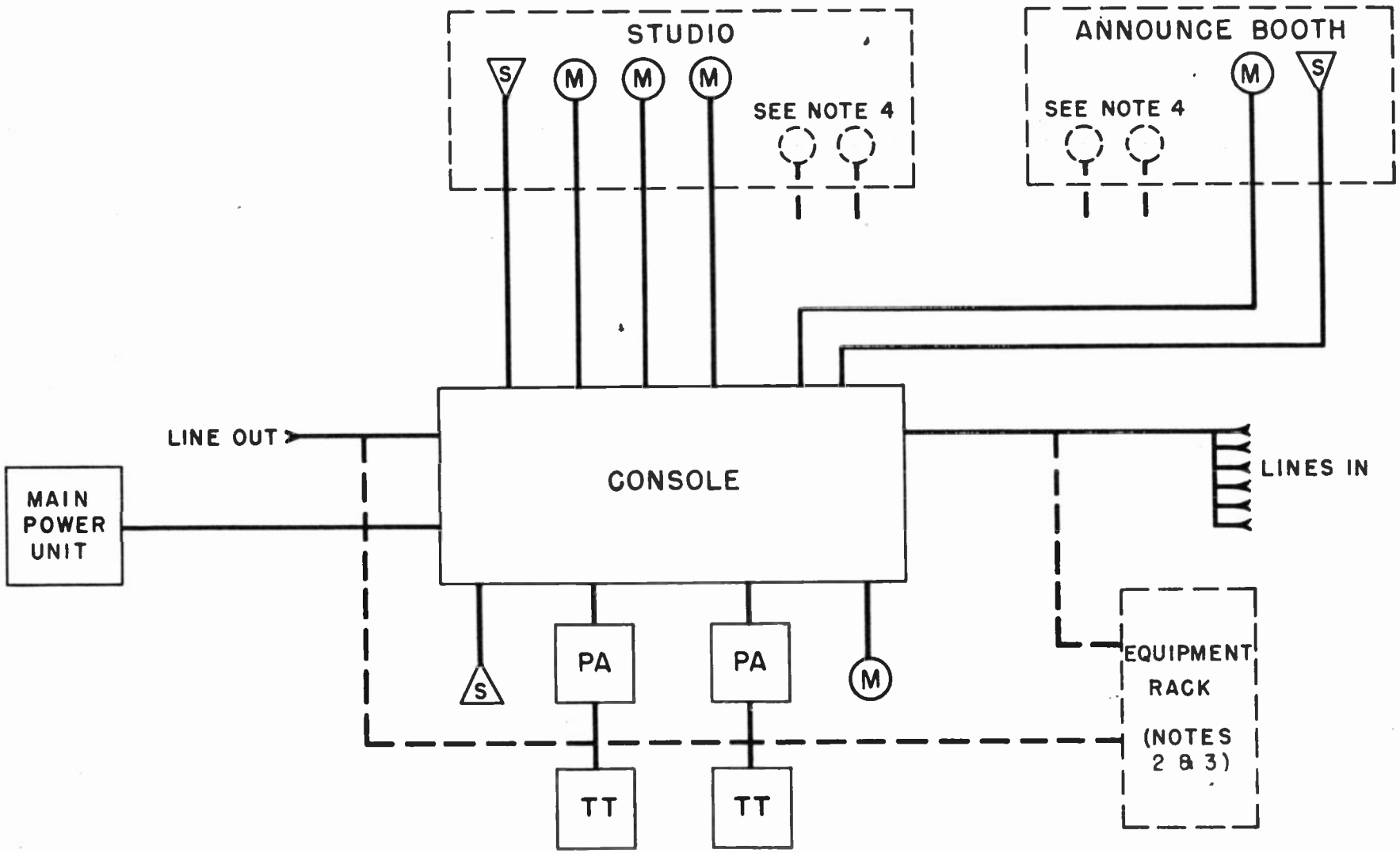
List 1

	Item	Suppliers Number			Suplier	Amount
1	Speech Input Consolette 76-B2	RCA	MI	11613-A1	RCA	1
2	Power Supply for Item 1	RCA	MI	11301-B	RCA	1
3	Tube Kit for Item 1	RCA	MI	11252	RCA	1
4	Transcription Turntable 70-C2	RCA	MI	4871-G	RCA	2
5	Booster Amplifier BA-2A (Used with Item 4 to raise output to mixing level)	RCA	MI	11226	RCA	2
6	Tube Kit for Item 5	RCA	MI	11287	RCA	2
7	Polydirectional Microphone 77-D (For use in studio)	RCA	MI	4045	RCA	2
8	Velocity Microphone 44-BX (For use in studio)	RCA	MI	4027-D	RCA	1
9	Pressure Microphone 88A (Announce Booth & Control Room)	RCA	MI	4048-D	RCA	2
10	Boom stand 90-C (For use in studio)	RCA	MI	4094-A	RCA	1
11	Floor stands 90-A (For use in studio)	RCA	MI	4090-A	RCA	2
12	Announce stand (For use in announce booth and control room)	RCA	MI	4096	RCA	2
13	Wall receptacle (One required for each microphone)	RCA	MI	4624-A	RCA	5
14	Microphone plugs (One required for each microphone)	RCA	MI	4630-B	RCA	5
15	Wall housing speaker (For use in announce booth and control room)	RCA	MI	12414	RCA	2

	Item	Suppliers Number	Supplier	Amount
16	Monitoring speaker 64-B (For use in control room)	RCA MI 4400/4410	RCA	1
17	Solid conductor cable (Interconnection between units)	RCA MI 63-A	RCA	1000
18	Fixed attenuator 600/600 ohm (Line isolation pad)	Daven DDDO		1

This is considered a minimum of equipment for studio facilities.

Purchaser will furnish table or desk for mounting Consolette and all power wiring, distribution equipment, conduit, outlet boxes and junction cabinets.



NOTE 1 - FACILITIES SHOWN IN SOLID LINES SUPPLIED BY LIST 1.

NOTE 2 - FOR LINE INPUT AND JACK PANEL EQUIPMENT SEE LIST 1A.

NOTE 3 - FOR STUDIO MONITORING EQUIPMENT SEE LIST 1B.

NOTE 4 - FOR STUDIO WARNING LIGHT EQUIPMENT SEE LIST 1C.

SIMPLIFIED TWO STUDIO SCHEMATIC

7423273

Descriptive Specification

Type 76B2 Consolette

The 76-B2 Consolette has been designed for use in broadcast speech input installations to provide a complete and flexible audio system in one conveniently arranged control unit. All the necessary functions of switching, mixing, and amplifying the audio outputs of microphones, transcription turntables, or remote lines, auditioning, and monitoring are accomplished in a single consolette.

The type 76-B2 Consolette consists of a cabinet, 39 inches wide, 17 inches deep and 10-1/2 inches high, containing the amplifiers, relays, transformers, etc., mounted on a hinged chassis. On the sloping front panel are mounted a large type VU meter, attenuators, switches, controls, jacks, etc. The VU meter can be used to check tube currents by means of the "tube check" switch. The tubes, relays, and other components may be inspected and serviced by raising the lid of the Consolette.

The entire Consolette is hinged along the back and may be raised for reaching the terminal boards, or for servicing the amplifiers or other components. When the Consolette is opened by raising the cabinet, terminal strips for power and low and high level audio frequency connections are accessible. These terminal strips are mounted on the stationary base plate.

Metal tubes are used throughout. Tubes operated at extremely low audio levels are shock mounted individually in their sockets.

The equipment is mounted on five rubber-cushioned mounting plates within the cabinet. These mounting plates are located left to right as

follows:

(1) Relay mounting plate, on which are mounted the three relays, capacitors, resistors, etc. Two terminal boards used for easy change over from two to one or three studio operation are also located under this plate.

(2) Monitor amplifier mounting plate, on which are mounted the components of the monitor amplifier and monitor amplifier booster stage.

(3) Line transformer mounting plate, on which are mounted the two line transformers and associated resistors.

(4) Pre-amplifier mounting plate, on which are mounted the four pre-amplifiers.

(5) Program amplifier mounting plate, on which are mounted the components of the program amplifier and the program amplifier booster stage.

The 76-B2 Consolette is finished in a soft two-tone umber grey.

The following tubes are required:

11 - RCA 1620 Radiotrons

2 - RCA 1621 Radiotrons

2 - RCA 1622 Radiotrons

Electrical characteristics are:

Gain --

(A) Microphone input to line output
112 DB

(B) Transcription input to line output
82 DB

(C) Line input to line output
55 DB

(D) Microphone input to monitor output
110 DB

(E) Transcription input to monitor output
81 DB

(F) Line input to monitor output
54 DB

(G) Cue input to monitor output
34 DB

(H) Talk back input to monitor output
96 DB

(I) Line input to monitor output
30 DB

(J) Microphone input to emergency line output
90 DB

(K) Remote line through override
29 DB

Line Output Level --

Normal; -16 DB (0 DB = .001 watt) with 0.5% R.M.S. harmonic distortion from 50 to 7000 cycles.

Maximum; +26 DB (0 DB = .001 watt) with 1.0% R.M.S. harmonic distortion from 50 to 7000 cycles.

Inputs --

(A) Six 30/250 ohm microphone inputs (balanced)

(B) Six 150/600 ohm line inputs (balanced)

(C) Two 250 ohm transcription inputs (unbalanced)

(D) One 250 ohm talkback microphone (balanced)

(E) Five 20,000 ohm monitor cue lines (balanced)

Outputs --

(A) One 500/600 ohm line

(B) Three 15 ohm monitor lines

(C) One high impedance headphone output (2000 to 5000 ohms)

Line Output Noise Level --

At normal gain (72 DB)

60 DB below normal output of +16 DB (0 DB = .001 watt)

Distortion --

(A) Microphone input to line output

0.5% R.M.S. harmonic distortion from 50 to 7000 cycles with normal output of +16 DB (0 DB = .001 watt).

(B) Microphone input to monitor output

4.0% R.M.S. harmonic distortion from 50 to 7000 cycles with 8.0 watts output.

Frequency Response --

(A) Microphone input to line output

± 2.0 DB 30 to 15,000 cycles.

(B) Microphone input to monitor output

± 2.0 DB 30 to 15,000 cycles (audition channel)

Monitor Power Output --

(A) 4.0 watts (+ 36 DB referred to 0 DB = .001 watt) with 2% R.M.S. harmonic distortion from 50 to 7000 cycles.

(B) 8.0 watts (+ 39 DB referred to 0 DB = .001 watt) with 4% R.M.S. harmonic distortion from 50 to 7000 cycles.

Attention is directed to the following operational notes concerning the 76-B2 Consolette.

(1) Provision is made for six microphone input circuits. Only four microphone preamplifiers are furnished with the type 76-B2 Consolette. Three of these preamplifiers are connected directly to microphone input circuits. The fourth preamplifier may be switched to any one of the three remaining microphone input circuits. Only one of

these microphones may be operated at a time. This may be easily explained by referring to the functional schematic drawing of the type 76-B2 Consolette. (Drawing P-7717663)

(2) Provision is made for six remote line and two transcription inputs. However, these inputs are connected to two mechanically interlocked push key switches whose outputs feed two mixer positions. Only one line or one transcription input can be connected at the same time to each mixer input. By means of the push keys this choice of input can be easily switched.

(3) Transcription turntable input circuits are not provided with built-in preamplifiers. High quality pickup output levels seldom exceed -70 DB (0 DB = .001 watt). Preamplification must, therefore, be furnished by exterior apparatus.

(4) If the output of the type 76-B2 is fed directly to a telephone line, a 6 DB pad should be inserted between the program amplifier output and the line. This enables the amplifier to operate into a constant impedance load.

The type 76-B2 Consolette should be mounted on a desk or special table of approximately desk height. This desk or table is not furnished with or considered a portion of the Consolette. The Consolette should be so located that the engineer operating the equipment will have an unobstructed view of the studio or studios at all times.

Power Supply --

The necessary power supply for the operation of the type 76-B2 Consolette is furnished by the MI-11301-B power unit. The MI-11301-B power unit is designed to operate from an A.C. source of 115 volts, 50 to 60 cycles and to supply plate, filament, relay, and other power to

the type 76-B2 Consolette. It is contained in a dark umber grey wall mounting steel cabinet 15 inches high, 15 inches wide, and 8 inches deep. Tubes required are 1 - RCA 5U4G and 1 - RCA 5Y4G. Power consumption is 225 watts.

All tubes, switches, terminal boards, and wiring are accessible from the front of the unit through the hinged door. Component parts, such as transformers, capacitors, and resistors, are accessible from the rear of the chassis by swinging the chassis outward on the hinges provided for that purpose. Ventilating screens are provided on the top and bottom of the cabinet. Knockouts for conduits are provided in either side. Terminal boards are provided for all connections. Emergency operation is provided by interconnection of the rectifier power units.

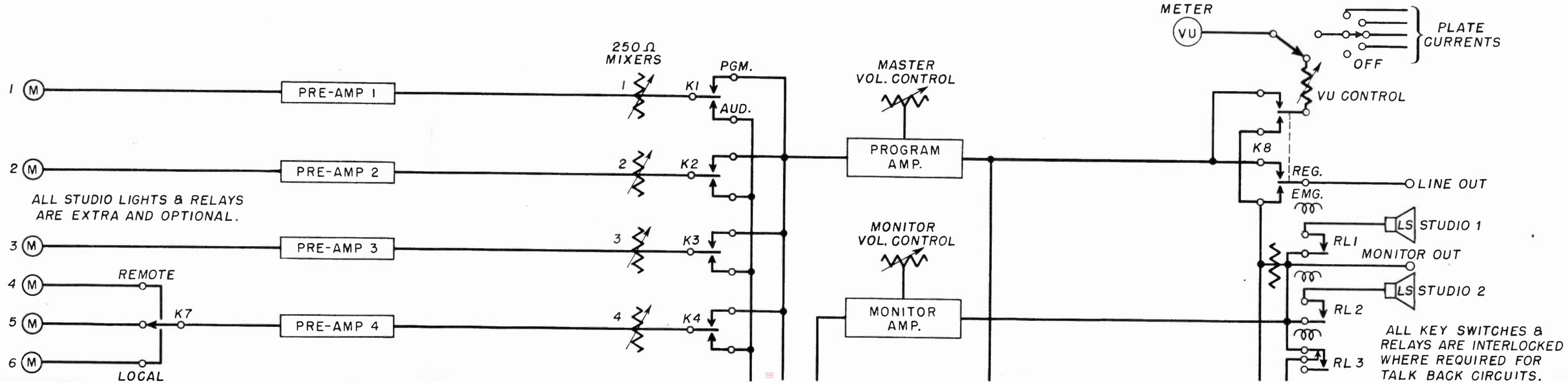
Installation --

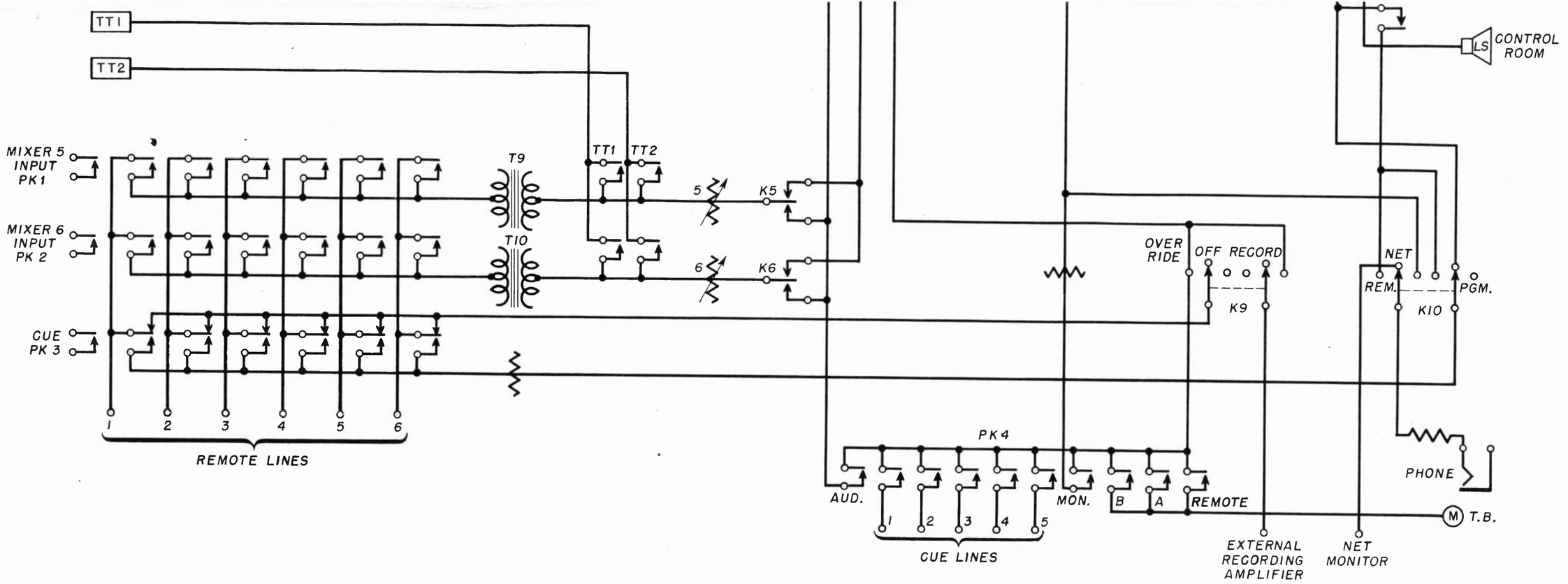
No installation materials are furnished with the type 76-B2 Consolette or the NI-11301-B power unit. Power leads are normally installed in either rigid or flexible conduit with standard wires and cable to be obtained and installed by the customer.

Drawing List

Block Diagram of 76B2 Consolette
7717663

THIRD ANGLE PROJECTION
DIMENSIONS IN INCHES





DWG. NO. P-7717663

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C. B. Co., 11-44

BLOCK DIAG. OF 76B2 CONSOLETTE

FIRST MADE FOR 6-08601-16	P-7717663	SUB. O
BEGUN BY	TRACED BY	
FINISHED BY P. CARTER 5-20-46	INSPECTED 5-20-46	
WESTINGHOUSE ELECTRIC & MFG. CO., BALTIMORE, MD.		

Studio Audio Frequency Facilities

List 1A

Line Input and Jack Panel Equipment

In order to provide overall operating flexibility, not obtainable when all connections are made by soldering on a terminal block, it is customary to provide a jack panel which is installed in such a manner that circuits can be temporarily connected by means of jacks and patch cords. The equipment of this list is recommended as a basic jack panel and line input rack.

The Type 9-AX cabinet rack serves to support and enclose the line equipment. Smaller racks and cabinets are available and are large enough to contain the basic equipment. However, their use is not recommended due to the fact that any need for future expansion causes them to be removed and discarded. Room for expansion of line and monitoring facilities is provided by a standard 77 inch rack such as the Type 9-AX.

It is suggested that the rack mounting space be divided as proposed in Drawing 7423565.

Two Type 33-AW jack panels containing double jacks are mounted in Space 1. These jack panels are faced with a jack mat which covers all exposed raw edges. Input lines from the Type 76-B2 consolette are "normalled" through these jacks to the incoming wire lines. Three two foot double patch cords are provided for making temporary "patches" or connections.

Incoming network lines are ordinarily pre-equalized by the telephone company to deliver a fixed frequency response, and require no further treatment. However remote pickup lines within the local toll

area can generally be obtained with or without equalization. It is customary for most broadcast stations to lease "Bare" or unequalized lines within these areas because of economic considerations. These lines can then be equalized by the broadcaster to the response required by the program material. In many cases a single line is used as a program line and as a communication circuit both before and after the program. In these cases it is more convenient if the broadcaster has control of the line equalization. Any equalization loss may be removed for communications use and replaced for program use. A single equalizer may be used for equalizing a number of telephone lines by switching or patching.

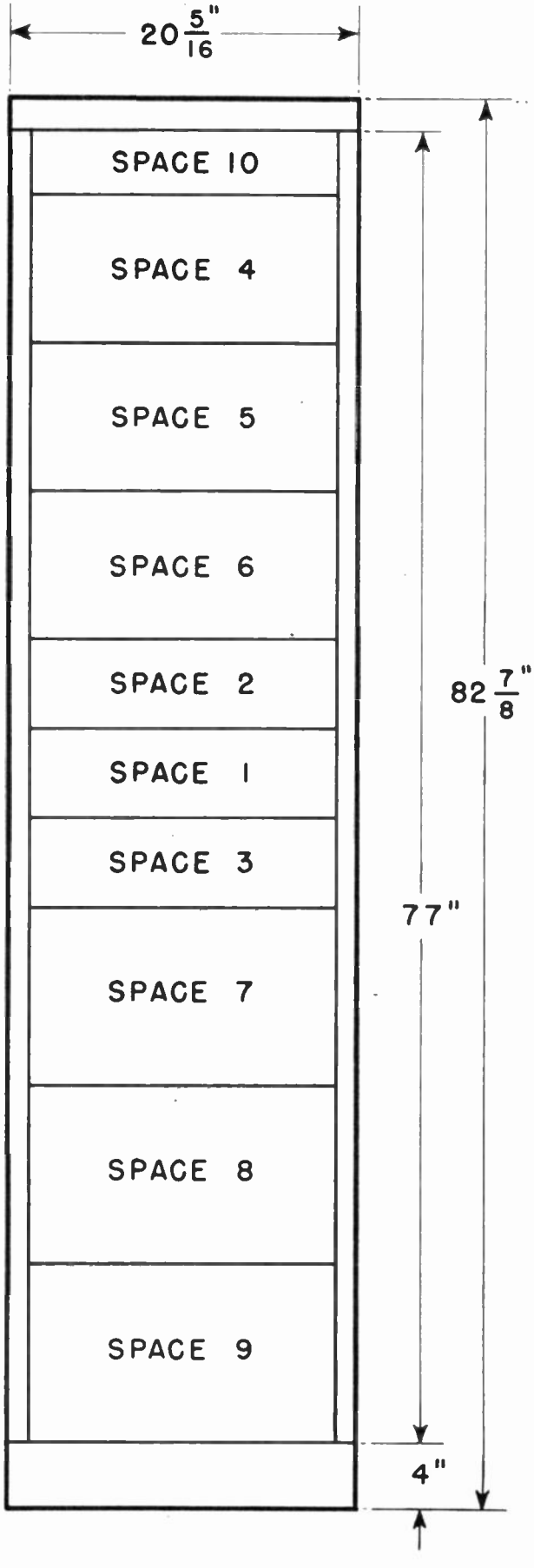
To allow equalization of telephone lines up to ten miles in length to a frequency response within ± 1 db from 30 to 15000 cycles, Type BE-1A variable equalizer is mounted in Space 3.

Space 2 is covered by a 5-7/32 inch blank panel. This size panel has been chosen for this space with the idea of replacing it at a later date with a jack panel identical with the one used in Space 1.

Spaces 4, 5, and 6 are covered with 8-23/32 inch blank panels. As equipment is added to the rack these blank panels are replaced by Type 36B panel and shelf assembly. In this manner it is necessary to discard only the removed blank panel. Other panels are not disturbed.

Terminal strips for both high and low level audio frequency and power termination are located behind Space 9. Spaces 7 and 8 are filled with blank panels.

In order to present a complete and finished appearance two "J" strips are mounted along the side of the cabinet and cover both mounting slots and mounting screws.



SUGGESTED RACK LAYOUT

7423565

Cabinet rack and panels are finished in Umber Grey. Base dimensions of the cabinet rack are width 20-5/16 inches, and depth 14-3/16 inches.

If the transmitter is located within the control room, the various unused portions of the rack space can be used to mount the necessary frequency and modulation monitor, or any standard rack mounted equipment. No equipment of this kind is supplied with List 1A.

Suggested placement of racks is shown on Drawings 7423269, 7423270, 7423271 and 7423272.

Bill of Materials for List 1A

Drawing List

7423565

BILL OF MATERIALS

List 1A

Jack Panel and Line Input Equipment

	Item	Suppliers Number			Supplier	Amount
1	Cabinet rack type 9-AX	RCA	MI	4519-E	RCA	1
2	Terminal block mounting bracket	RCA	MI	4570	RCA	1
3	Audio terminal block	RCA	MI	4569	RCA	3
4	Power terminal block	RCA	MI	4568	RCA	1
5	Jack panels 33-AW	RCA	MI	4536-A	RCA	2
6	Jack mats double	RCA	MI	11502-A	RCA	1
7	Variable line equalizer BE-1A	RCA	MI	4196	RCA	1
8	Patch cords two feet	RCA	MI	4652-2A	RCA	3
9	"J" strips	RCA	MI	4537-D	RCA	2
10	Blank panel 3-15/32"	RCA	MI	4591-B	RCA	1
11	Blank panel 5-7/32"	RCA	MI	4592-B	RCA	1
12	Blank panel 8-23/32"	RCA	MI	4594-B	RCA	3
13	Blank panel 10-15/32"	RCA	MI	4595-B	RCA	3
14	List 1					1

Studio Audio Frequency Facilities

List 1B

Studio Monitoring Equipment

The Type 76-B2 Consolette provides monitoring facilities for three loudspeakers only. Customarily these loudspeakers are located in the control room, studio and announce booth. Ordinarily there are other points within the studios requiring monitoring loudspeakers. It is the purpose of List 1B to suggest combinations of monitoring equipment for any studio.

The Bill of Materials is based on one Type BA-4A monitoring amplifier. This amplifier is bridged to the output terminals of the 76-B2 Consolette using two 5000 ohm resistors as the series arms and a 250 ohm resistor as the amplifier termination. Connecting the amplifier in this manner has no effect on the output of the Consolette.

The output of the Type BA-4A amplifier can be used to feed program to three Type 64B loudspeakers or to six wall housing speakers. Choice of loudspeaker combinations should be made from items 6 and 6A or from 6-1.

The combination of speakers is here given as a suggestion only. Owing to volume level tolerances and to impedance matching schemes it is impossible to list a bill of materials to cover all possible speaker combinations. In general it will be found desirable to use the type 64B loudspeakers where high level, high quality monitoring is necessary and the wall housing speakers for routine listening and cue purposes where lower volume and quality standards are acceptable.

The type BA-4A amplifier mounts on Type 36B panel and shelf assembly which can be mounted in either space 4, 5, or 6 of the equipment rack. The blank panel furnished for List 1A is not used if a type 36B panel is used.

Tube complement of tube kit listed is -

Tube Kit WI-11267 (BA-4A Amplifier)

4 - RCA 1620

2 - RCA 1622

1 - RCA 5U4G

Bill of Materials for List 1B.

BILL OF MATERIALS

List 1B

Studio Monitoring Equipment

	Item	Suppliers Number	Supplier	Amount
1	Monitoring amplifier BA-4A	RCA MI 11223	RCA	1
2	Tube kit for Item 1	RCA MI 11267	RCA	1
3	Resisters 5000 ohms	IRC BT-1	IRC	2
4	Resister 250 ohms	IRC BT-1	IRC	1
5	Panel and shelf assembly 36-B	RCA MI 4682-H	RCA	1
6	Monitoring speaker 64-B	RCA MI 4400/4410	RCA	3
6A	Base for Item 6 (if desired)	RCA MI 4405	RCA	-
6-1	Wall housing speaker	RCA MI 12414	RCA	6
7	List 1			1
8	List 1A			1

NOTE: 1 each blank panel 8-23/32" blank panel MI-4594-B on list 1A will be replaced for each panel and shelf assembly 36-B MI-4682-H used with this list.

Studio Audio Frequency Facilities

List 1C

Studio Warning Light Equipment

To provide a visual indication of "Audition" or "On Air" conditions, a sign should be placed in each studio. It is customary to make these signs of two panes of glass, colored and framed in keeping with the studio decorative scheme and illuminated from the rear. The type 76B2 Consolette is provided with facilities to operate such signs. For two studio or one studio and one announce booth operation both power and switching facilities are furnished by the 76B2 Consolette. In this case it is necessary to provide only one relay for each light to be controlled. An "On Air" and an "Audition" light in each of two studios can be furnished by four relays. These relays make and break a 110 volt circuit to the lamps and two relays can be installed at any convenient position in a standard Columbia Type "A" 6 x 6 x 4 inch steel cabinet. Cabinets for mounting signs and relays, signs and electrical wiring are to be furnished by the purchaser.

Switching facilities for "On Air" warning lights for one or two additional studios or announce booths are also furnished by the 76B2 Consolette. However, no relays for speaker muting or light switching or power for their operation is furnished. A single power supply will furnish power for either one or two studios. Two relays are required for each studio, one to mute the speaker and one to light the "On Air" sign. No "Audition" signs can be operated in the additional studios or announce booths.

Sugrested locations of warning signals are shown on drawings 7423273, 7423274 and 7423275.

BILL OF MATERIALS

List 1C

Studio Warning Light Equipment

Item	Suppliers Number	Supplier	Amount
(Equipment for 1 or 2 studios or 1 studio and 1 announce booth only)			
On Air Light Relay (* One each relay is required for each "On Air" or "Audition" light to be operated)	RCA MI 11702	RCA	*
List 1			1
(Equipment for one announce booth or speakers studio, in addition to above, to operate "On Air" light and mute speaker only)			
Relay Power Supply	RCA MI 11303	RCA	1
On Air Light Relay	RCA MI 11702	RCA	1
Speaker Relay	RCA MI 11703	RCA	1
(If two announce booths or speakers studios are required add to list above)			
On Air Light Relay	RCA MI 11702	RCA	1
Speaker Relay	RCA MI 11703	RCA	1

Studio Audio Frequency Facilities

List 1D

Remote Pickup Equipment

The type 22-D portable Speech Input Equipment provides complete pickup facilities for broadcast programs remote from the studios. It is designed for fast setup, is simple in operation and can be handled easily by one man.

The 22-D consists of a combination amplifier-control unit, with a carrying case, a rectifier unit for AC operation and/or a battery rack assembly with a carrying case, together with the necessary interconnecting and power cords.

Controls and the volume indicator meter are on the front panel of the amplifier-control unit. Microphone input receptacles are at the left end and the output terminals, monitoring head set jacks, order wire telephone set connections and power receptacles are at the right end.

Each carrying case is divided into two compartments, one houses the principal unit and the other houses accessories. Each case measures approximately 41 inches high, 16-3/4 inches long and 7-3/4 inches deep, is made of plywood and covered with black fabrikoid.

The 22-D Equipment includes a four channel paralleled mixing circuit, designed to work with 30 ohm dynamic microphones or other 30 ohm sources of comparable level. The output circuit includes line isolation pads and is designed to work into an impedance of either 150 or 600 ohms, the selection of which is made by means of a screw-driver adjustment.

When operated between the impedance mentioned above, namely 30 and 150 or 600 ohms, the maximum overall net gain of the system approximates 92 db. Normal output levels between +6 VU and +14 VU can be obtained readily by using the master gain control located between the first and second stages which provides an attenuation up to 45 db and by using the four channel mixing circuit which is ahead of the amplifier and furnishes an additional attenuation of as much as 45 db.

The frequency characteristic is uniform within ± 1 db from 30 to 10,000 cycles and the harmonic distortion under normal operating conditions is less than one percent at output levels as high as +18 VU.

The 22-D Speech Input Equipment may be operated from either AC or battery supply. For AC operation, a 110-120 volt, 50-60 cycle source capable of supply 28 watts is required. When operated from batteries, 1.4 amperes at 6 volts and 21 milliamperes at 180 volts are required. Individual switches allow either filament or plate supply to operate from rectifier or batteries. When operating from batteries the volume indicator illuminating lamps may be disconnected by means of a panel switch.

The following tubes are required:

2 - RCA 1620 or 6J7

2 - RCA 1621 or 6F8

1 - RCA 80

For monitoring purposes 2 each Western Electric 1002-F headsets are supplied.

Two each Type 77-D polydirectional microphones and two each Type 68-A pressure microphones are supplied. Three Type 59-B portable

microphone stands and one banquet microphone stand are supplied.

A microphone carrying case, 39-1/2 inches long, 9-1/2 inches high and 11 inches deep covered on the outside with fiber and on the inside with soft felt provides protection and a convenient method of transportation for the microphones, the folded stands, one 100 foot microphone cord extension, two 50 foot microphone cord extensions and miscellaneous tools and cords.

No telephone intercommunication equipment is supplied as methods of communication between pickup and studio vary widely. If a portable telephone is required the Western Electric 301-A portable telephone set is recommended.

BILL OF MATERIALS

List 1D

Remote Pickup Equipment

	Item	Supplier	No.	Supplier	Amt.
1	Speech input equipment (complete with KS-8208 motor and AC power supply per ESR-61099-1, Issue 5)	WE	22D	WE	1
2	Vacuum tubes	RCA	1620	RCA	4
3	Vacuum tubes	RCA	6F6	RCA	2
4	Vacuum tubes	RCA	80	RCA	2
5	Panel Receptacles	Cannon	P3-13	Cannon	4
6	Polydirectional microphone 77D	RCA	MI-4045	RCA	2
7	Pressure microphone 88A	RCA	MI-4048-D	RCA	2
8	Cord connectors	RCA	MI-4620-B	RCA	3
9	Portable stand 59-B	RCA	MI-4093-B	RCA	3
10	Banquet stand	RCA	MI-4095	RCA	1
11	Headsets	WE	1002-F	WE	2
12	Microphone plug	RCA	MI-4630-B	RCA	7
13	Microphone cable	RCA	MI-43	RCA	200'
14	Microphone carrying case	RCA	MI-4085	RCA	1

NOTE: No telephone communicating equipment is provided by this list.

Studio Audio Frequency Facilities

List 1E

Fixed Recording Equipment

For making high quality master and instantaneous recordings at the studio location, List 1E is required. This equipment is intended for fixed use only and should be installed in a permanent manner. No desks or mounting tables are furnished and the arrangement of components will be that of the customers choice when installed.

To provide facilities for continuous recording two type 8-D Recording Turntables are supplied. The turntable, which weighs 20 pounds, is of cast iron, accurately machined and dynamically balanced, having a hardened steel shaft which revolves on a single ball bearing at the base of a bronze sleeved shaft well. A heavy duty, self starting synchronous 1/25th horsepower motor supplies power to the inside rim of the turntable through a steel step pulley and two rubber idler wheels, one of which is engaged at 78 rpm and the other at 33-1/3 rpm. The locking speed shift lever operates the motor switch for starting and stopping the motor, and selects the speed at which the turntable operates. Adjustable stops regulate the travel of the speed shift lever to maintain a constant pressure against the idler wheels. The turntable and drive assembly are mounted on a cast iron mounting base weighing 60 pounds and provided with three adjustable mounting feet for leveling.

The cutter feed mechanism consists of a heavy, machined, stainless steel guide bar mounted on the turntable base. Provision is made

for swinging the entire mechanism from the recording position to the rear to clear the turntable for changing records. The feed screw is driven through a belt and pulley system, operated from the turntable shaft and a worm and gear in the housing of the cutter mechanism mounting. The belt on the step pulleys slips instantly to any position and sets the feed screws cutting pitch to 96, 104, 112, 120, 128 or 136 lines per inch. This adjustment eliminates the need for changing feed screws as all cutting pitches are available with a single feed screw. The spiralling attachment makes it possible to space grooves up to 1/2 inch apart at convenient crank speeds. A four sided time scale shows elapsed recording time.

The cutting head is mounted on an apron, hinged to permit a rough adjustment of the cutting angle. This adjustment is locked by means of a thumb screw. Fine adjustment of the cutting angle is made by means of a large thumb screw at the top of the carriage. The cutting head may be swung outward to a horizontal position to change cutting needles and may be replaced, in cutting position without disturbing the cutting angle. Levers are provided for lowering the cutting needle gently on the disc and for engaging the cutting head carriage with the feed screw. A vertical damper is mounted on a rocker arm beneath the carriage. The depth of cut is adjusted by a counterbalance spring at the side of the cutting head. Type 1-C Cutting Heads furnished have a uniform frequency response from 50 to 8000 cycles per second. The frequency range can be extended beyond 10000 cycles per second with the equalizers furnished. The type 1-C Head will fully modulate a groove cut at 112 lines per inch with an input level of + 28 db (0 = .001 w). Grooves cut at 96 lines per inch may be fully modulated with an input

level of + 30 db (0 = .001 w). Measurements made from a fully modulated groove cut at 96 lines per inch show less than 4% distortion at 100 cycles per second and 1.5% above 1000 cycles per second. The input impedance of the type 1-C Cutting Head is 500 ohms.

The type 160A Automatic Equalizers mount on the cutting head carriage and have a sliding contact mechanically coupled to the cutting head. As the cutting head moves across the record it adjusts a resistance network to alter the frequency response curve of the amplifier to compensate for the high frequency attenuation at various groove radii and at the same time to hold the audio input to the cutting head at a constant level.

A microscope equipped with a rigid cast aluminum mounting bracket and a special lamp allows minute inspection of an area of approximately 7 grooves.

The type 8-D Recorders are finished in gray crackle enamel with chromium trim and each require a mounting area 31 inches long, 18 inches deep and 19-1/4 inches high.

The Recording Amplifier furnished to supply audio power for driving the cutting heads is a Type 88A. This amplifier has been chosen because of its 50 watt power output and the choice of recording systems available. An adjustment on the front panel allows a choice of three calibrated frequency response curves. The first is uniform within 1 db from 20 to 17000 cycles per second. The second has a rising high frequency characteristic which complements the "NBC Orthacoustic" playback system and the third complements the standard high fidelity lateral playback system. Changes in frequency response due to varying groove diameter are compensated by the type 160A Equalizers.

The type 88A Amplifier has less than 1-1/2% distortion at full output and a gain of 85 db. A bridging transformer is supplied to allow the input to be bridged to a 500 ohm circuit if desired. Tube complement includes one 6SF5, one 6J5, one 6C8, two 83 and four 807 tubes. The power supply is built-in and requires 160 watts 110 volts 50/60 cycles.

The amplifier is rack mounted requiring 14 inches of standard rack space. It may be mounted in the type 9 AX Rack supplied by List 1A. The panel is finished in gray enamel.

The type 86B Control Panel provides controls for two independent recording channels each consisting of a gain control, cutter and equalizer changeover switches for continuous recording, volume indicator meter and a switch for selecting the equalizer peak frequency. Although only one recording channel is supplied by this list, the addition of another recording amplifier at a later date completes a two channel system without change in recording control panels. The type 86B Control Panel permits a change in volume levels, change in peak equalization frequency and continuous or simultaneous recording from the recording position.

Playback facilities are not supplied. It is contemplated that playback equipment will be located nearby to provide both recording checks and broadcast use.

BILL OF MATERIALS

List 1E

Fixed Recording Equipment

	Item	Suppliers' No.	Supplier	Amount
1	Recording Turntable	Presto 8-D	Presto	2
2	Recording Amplifier	Presto 88A	Presto	1
3	Recording Control Panel	Presto 86B	Presto	1
4	Bridging Transformer	RCA MI-4901	RCA	1
5	Recording Discs	Presto 616A	Presto	100
6	Recording Cutting Needles	Presto 604A	Presto	5

Mounting tables or desks to be furnished by customer.

Studio Audio Frequency Facilities

List 1F

Portable Recording Equipment

Portable Recording Equipment for making records and transcriptions at a point remote from the studios is supplied by List 1F.

Two 6N Recording Turntables are furnished. These turntables consist of a heavily ribbed cast aluminum base mounting a 10 pound cast aluminum turntable which is accurately machined and dynamically balanced. The turntable revolves on a hardened steel shaft in a bronze bushed shaft well and is supported by a single ball bearing. The turntable is driven by a self-starting, synchronous motor which applies power at the inside rim of the turntable through a steel pulley and two rubber idler wheels, one for 78 r.p.m., the other for 33-1/3 r.p.m. A locking speed shift lever operates the motor switch and engages the idler wheels. The rim pressure against the idler wheels is regulated by an adjustable stop. The turntable is covered by a heavy rubber mat.

The cutter mechanism swings from a cast, bronze bushed bearing in the turntable base. A flange which fits over the turntable shaft drives the feed screw through a worm and gear. The entire mechanism moves to a rest at one side of the turntable when not in use. Provision is made for quick and accurate alignment of the cutting mechanism with the turntable and base. The spiralling feed screw makes it possible to space grooves up to 1/2 inch apart at convenient crank speeds. A time scale shows the elapsed recording time at both 78 and 33-1/3 r.p.m. at cutting pitches of 96-104-112 and 120 lines per inch.

The Cutting Head is mounted on an apron, hinged for quick adjustment of the cutting angle. A cam lever is provided for lowering the cutting needle on the disc. A knob on the cutter carriage lowers the feed finger under spring tension of the feed screw. A vertical damper for eliminating rumble or flutter due to vertical modulation is mounted beside the cutter carriage. The depth of cut is adjusted by a counter-balance spring. Feed screws can be changed quickly by loosening one thumb screw. The driving gear on the feed screw is permanently mounted and engaged with the worm on the drive shaft so that it cannot be damaged when feed screws are changed. Type 1-C Cutting Heads furnished have a uniform frequency response from 50 to 8000 cycles per second. The frequency range can be extended beyond 10000 cycles per second with the equalizers furnished. Recording grooves, when cutting 112 lines per inch, can be fully modulated by an input level of + 28 db (Ref. 0 = .001 w). Recordings cut at 96 lines per inch require an input level of + 30 db (Ref. 0 = .001 w). Measurements made from a fully modulated groove cut at 96 lines per inch show less than 4% distortion at 100 cycles and 1.5% above 1000 cycles per second. The Type 1-C Cutting Head has an impedance of 500 ohms.

Loss of high frequency response as the radius of the recording groove becomes smaller and the linear speed of the record past the needle becomes slower, is avoided by the use of Type 160 B Automatic Equalizers. The automatic equalizer holds the input of the cutting head at a constant level and at the same time continuously alters the frequency response of the amplifier to compensate for the loss in amplitude of the higher frequencies. The equalizer consists of a control box con-

taining a tuned circuit adjustable to peak the amplifier response at 4000, 6000, 8000 or 10000 cycles per second and a slider unit which attaches to the cutter feed mechanism. The sliding contacts move with the cutting head adjusting a resistance network to alter the frequency response curve of the amplifier to compensate for the high frequency attenuation at various groove radii and at the same time hold the input to the cutting head at a constant level. The Type 160-B Equalizer consists of one control box and two slider units for use with dual turntable installations.

The complete turntable equipment is arranged for portability and when packed for movement is contained in two cases each 20-1/4 inches wide, 20 inches high and 15 inches deep. Each case is provided with carrying handles and is covered with gray leatherette. Cutting heads, equalizers and overhead mechanism are packed in pockets in these cabinets. A spare feed screw is furnished.

The Type 85A Recording Amplifier is contained in a gray leatherette case 18-1/2 inches high, 17 inches wide and 13 inches deep. It consists of a three stage push pull amplifier, with built-in power supply. The power output stage and transformer are specifically designed to match the load characteristics of the Type 1-C Recording Head. Tubes used are 2 - Type 6L6, 4 - Type 6SJ7 and one Type 5Z3. A selector switch mounted on the front panel allows microphone recording, radio recording, playback using the pickups mounted on the 6N turntables and the 8 inch monitor loudspeaker of the type 85A amplifier or public address. Switches are arranged to facilitate changing to either turntable for continuous recording or playback. A gain of 90 db is provided. The

frequency response is flat from 30 to 15000 cycles. An output of 10 watts provides less than 1% distortion at the maximum level required by the 1-C Recording Head.

The Remote Pickup Equipment of List 1-D provides amplification and mixing facilities for recording. If only one microphone is required Item 8 of the bill of materials for List 1-F supplies a single type 40A Preamplifier. Power for the Type 40A Preamplifier may be obtained from the Type 85A Recording Amplifier. The output of this preamplifier matches the 85A input and a switch on the input permits the use of a choice of 50, 200 or 500 ohm impedance sources. Tubes required for the preamplifier are one type 6J7 and one type 6SJ7. All interconnecting cables are furnished with the equipment.

BILL OF MATERIALS

List 1F

Portable Recording Equipment

	Item	Supplier No.	Supplier	Amount
1.	Recording Amplifier	Presto 85A	Presto	1
2.	Recording Turntable	Presto 6N in 1B Carrying Case	Presto	2
3.	Automatic Equalizers	Presto 160B	Presto	1
4.	Feed Screw	Presto 32B01	Presto	1
5.	Recording Discs	Presto 616A	Presto	30
6.	Recording Cutting Needles	Presto 604A	Presto	4
7.	Microscope	Presto 125A	Presto	1

The Recording Amplifier may be fed program from remote pickup equipment as furnished by List 1D.

If only one microphone is necessary for recording Item 8 may be added to feed the Recording Amplifier

8.	Preamplifier	Presto 40A	Presto	1

Studio Audio Frequency Facilities

List 2

Three Studio Equipment

The basic two studio or one studio and one announce booth layout supplied by List 1 may be enlarged to serve two studios and an announce booth by the addition of the attached Bill of Materials.

Attention is directed to the fact that no additional input facilities are provided. The basic facilities of List 1 are rearranged and reassigned to allow input switching of additional microphones. Microphone inputs 1 and 2, as shown on the block diagram of the 76B2 Consolette (7717663), are assigned to Studio 1. Microphone input 3 is assigned to Studio 2 and microphone input 4 is switched between Studio 2, the announce booth or the control room as required. This switching operation is performed by a switch mounted on the front panel of the Consolette.

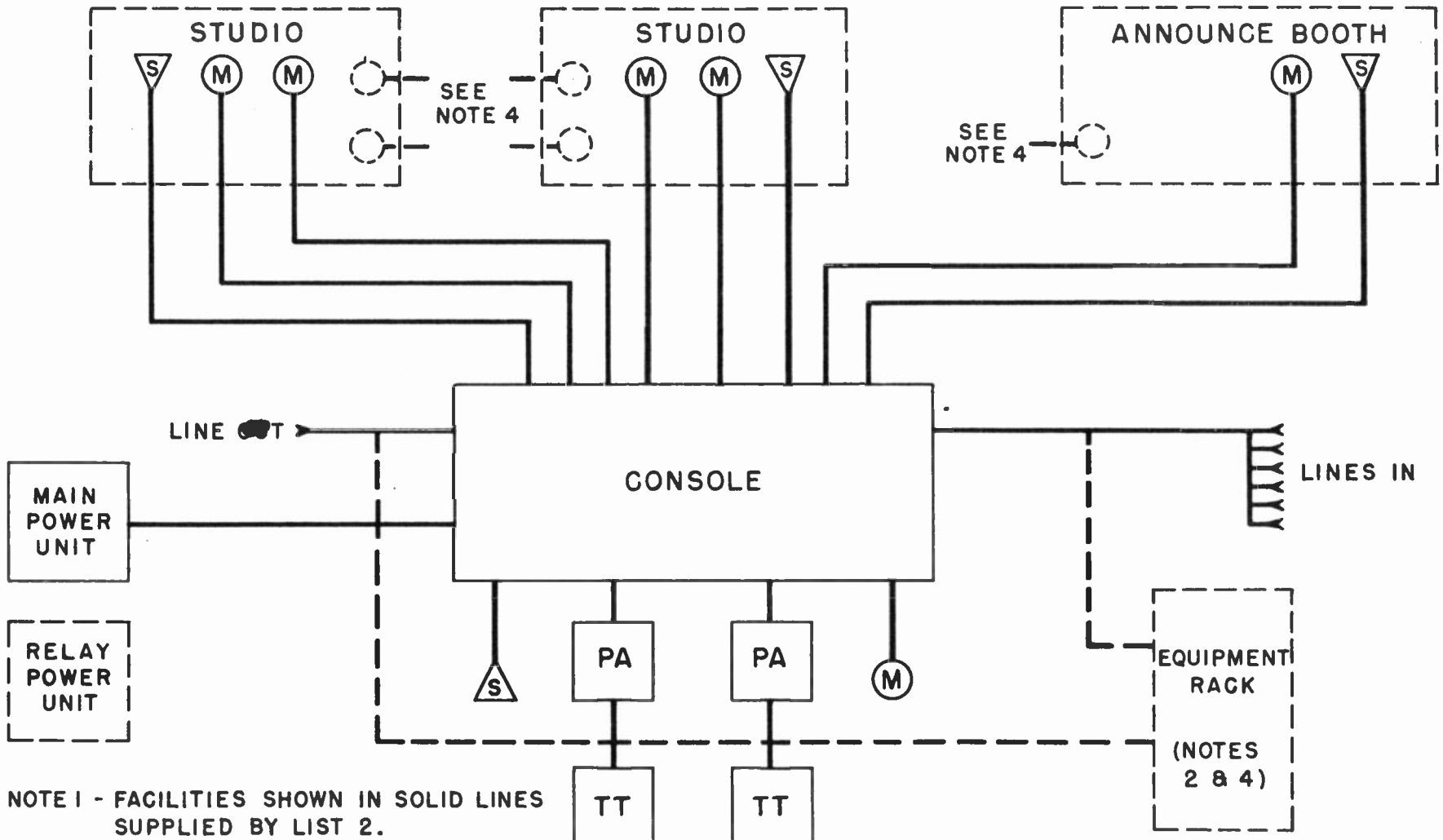
One additional microphone is required for three studio operation. Choice should be made from Items 1, 1A or 1B of the Bill of Materials according to the need of the purchaser.

Typical three studio architectural arrangements are shown by Drawings 7423269 and 7423271.

"On Air" and "Audition" warning lights may be operated in two studios and an "On Air" warning light in the third studio or announce booth. For details of warning light and speaker muting relay requirements see List 1C.

Drawing List

7423269, 7423271, 7423274



NOTE 1 - FACILITIES SHOWN IN SOLID LINES SUPPLIED BY LIST 2.
NOTE 2 - FOR LINE INPUT AND JACK PANEL EQUIPMENT SEE LIST 1A.
NOTE 3 - FOR STUDIO MONITORING EQUIPMENT SEE LIST 1B.
NOTE 4 - FOR STUDIO WARNING LIGHT EQUIPMENT SEE LIST 1C.

SIMPLIFIED THREE STUDIO SCHEMATIC

7423274

BILL OF MATERIALS

List 2

	Item	Suppliers Number	Supplier	Amount
1	Velocity microphone 44-BX or	RCA MI 4027-D	RCA	1
1A	Polydirectional microphone 77-D or	RCA MI 4045	RCA	1
1B	Pressure microphone 86A (Only 1 each microphone is required in studio)	RCA MI 4048-D	RCA	1
2	Wall receptacle	RCA MI 4624-A	RCA	1
3	Microphone plug	RCA MI 4630-B	RCA	1
4	Wall housing speaker	RCA MI 12414	RCA	1
5	List 1			1

Studio Audio Frequency Facilities

List 3

Four Studio Equipment

The basic two studio or one studio and one announce booth layout supplied by List 1 may be enlarged to serve two studios and two announce booths or speakers studios by the addition of the attached bill of materials.

Attention is directed to the fact that no additional input facilities are provided. The basic facilities of List 1 are rearranged and reassigned to allow input switching of additional microphones. Microphone inputs 1 and 2, as shown on the block diagram of the 76B2 Consolette (7717663) are assigned to Studio 1. Microphone input 3 is assigned to Studio 2 and microphone input 4 is switched to Studio 2 or to either announce booth (or speaker studio) as required. The switching operation is performed by a switch mounted on the front panel of the Consolette. It should be noted that the addition of another studio precludes the use of the microphone in the control room for making local "air" announcements. The control room microphone can be used only for talkback to the studios and remotes.

Two additional microphones are required for four studio operation. Choice of a program microphone should be made from Items 1 or 1A of the Bill of Materials according to the purchaser's needs. The second microphone is intended for voice use in the announce booth or speakers studio and is supplied by Item 2 of the Bill of Materials.

A typical four studio architectural arrangement is shown by Drawing 7423272.

"On Air" and "Audition" warning lights may be operated in two studios and an "On Air" warning light may be operated in the two announce booths or speakers studios. For details of warning light and speaker muting relays required see List 1C.

Drawing List

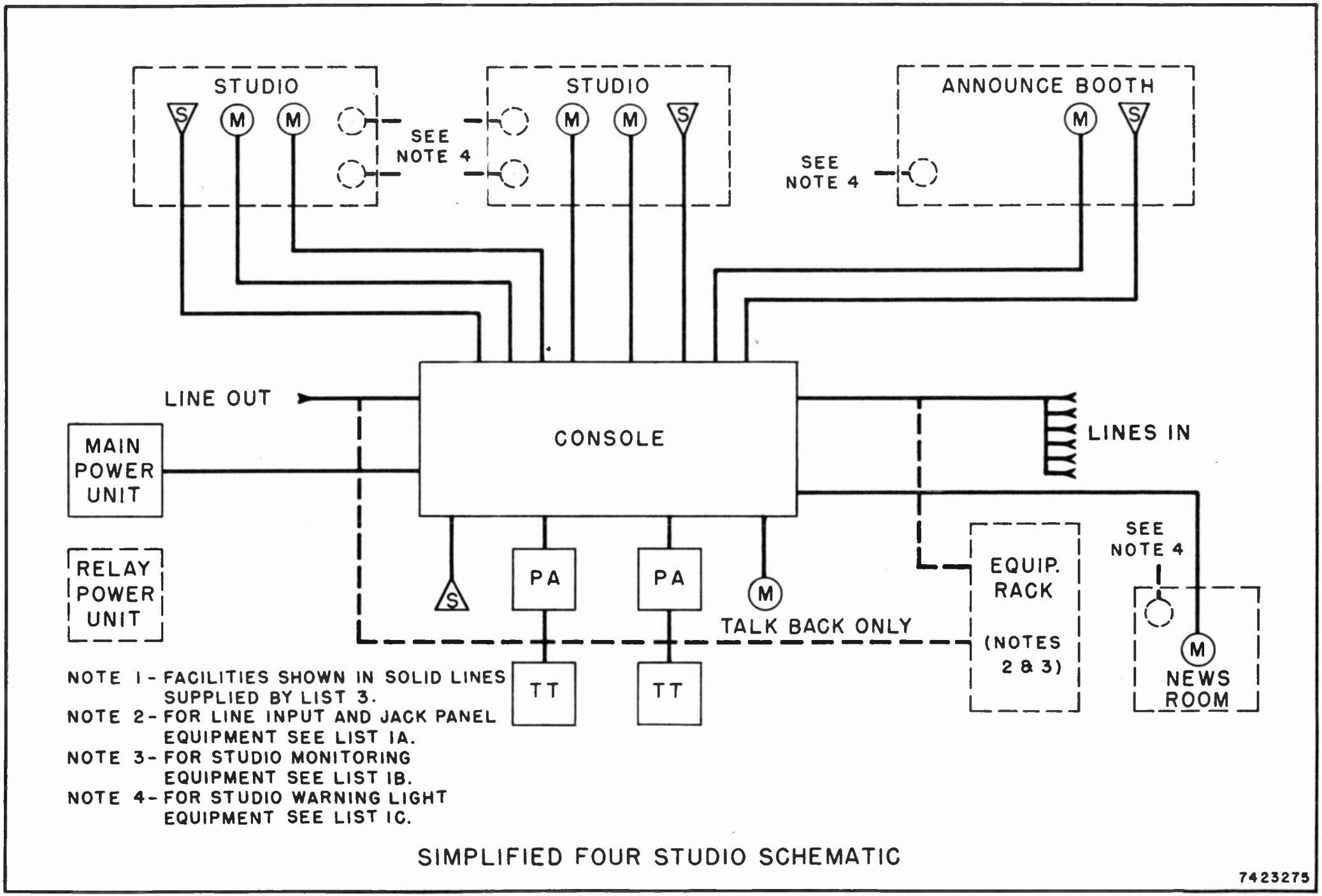
7423272
7423275

BILL OF MATERIALS

List 3

	Item	Supplier Number			Supplier	Amount
1	Velocity microphone 44-BX or	RCA	MI	4027-D	RCA	1
1A	Polydirectional microphone 77-D (Only 1 each micro-phone is required in studio)	RCA	MI	4045	RCA	1
2	Pressure microphone 88-A (For use in news room)	RCA	MI	4048-D	RCA	1
3	Wall receptacle	RCA	MI	4624-A	RCA	2
4	Microphone plug	RCA	MI	4630-B	RCA	2
5	Wall housing speaker	RCA	MI	12414	RCA	1
6	List 1					1

NOTE: Speaker for news room will be fed from house monitoring system. See List 15.



SIMPLIFIED FOUR STUDIO SCHEMATIC

7423275

DESCRIPTIVE SPECIFICATION

STUDIO AUDIO FREQUENCY EQUIPMENT

R-1831

WESTINGHOUSE ELECTRIC CORPORATION

INDUSTRIAL ELECTRONICS DIVISION

AUGUST 1946

CONTENTS

For
Remote Pickup Equipment
Fixed Recording Equipment
Portable Recording Equipment
See Lists 1D, 1E, and 1F Of
Descriptive Specification

Studio Audio Frequency Equipment
R-1775

STUDIO AUDIO FREQUENCY FACILITIES

BASIC AUDIO EQUIPMENT

The Bill of Materials attached to this list provides the minimum of audio frequency equipment required to establish a radio broadcasting studio system using a Type 25B Speech Input Equipment. This list provides equipment for two talent studios and a combination control room-announce booth. It may be used to program either an AM or a FM broadcasting station or by efficient traffic management may be made to program both an FM and AM station with separate material. A full description of the Type 25B Speech Input Equipment is furnished under the descriptive specifications covering this unit.

The two talent studios supplied are identically equipped. Each contains two Type 639A Cardioid Microphones mounted on floor stands. These floor stands are equipped with swivel mountings to allow the microphones to be adjusted to any position. The Type 639A Microphone is a combination of a dynamic moving coil type pressure element and an improved ribbon type velocity element enclosed in a single housing. An adjustment screw on the rear of the microphone provides three different patterns to be realized by means of a screwdriver. Use of the dynamic element alone provides a non-directional pattern, the ribbon element alone provides the familiar figure eight pattern and an equal combination of the elements produces the heart shaped cardioid directional characteristic. Each studio is also provided with one Type 633A Dynamic Microphone mounted on a floor stand and provided with both a swivel and a directional baffle. The rugged dependability of this "saltshaker" type, together with its small size and

light weight make it a welcome general purpose studio pickup device. Cue and monitoring for the studios is supplied by wall mounting Type 751B Loudspeakers. These speakers measure approximately 24 inches high by 17 inches wide by 13-1/2 inches deep and weigh about 42 pounds. They are finished in a plain grey lacquer finish but can be refinished to blend with any decorative treatment.

The combination control room-announce booth has a Type 633A Microphone mounted on a desk stand equipped with a swivel joint. A Type 753A Loudspeaker in a floor mounting walnut finished cabinet measuring approximately 20 inches wide by 30 inches high by 13-1/2 inches deep is used for monitoring purposes. The Type 753A Loudspeaker has a three-band loudspeaker system fed from a dividing network and is designed for use where the highest quality reproduction from 60 to 15000 cycles is necessary.

The Loudspeakers in both studios and in the control-announce booth are interlocked with the microphone keys, muting the speakers when a microphone is switched into circuit, preventing acoustical feedback caused by live microphones and speakers in the same studio.

Two Type 63B Transcription Turntables are furnished for the reproduction of recorded program material. Each of these turntables include a 16 inch dual speed turntable, combination vertical and lateral dynamic reproducer, compensating network and selector switch mounted in a two tone grey finished wood cabinet with chromium trim. The turntable speed is maintained to an accuracy of 0.5% at both 33-1/3 and 78 R.P.M. The reproducing needle is a diamond, hand lapped to fit standard groove dimensions. The selector switch for the compensating network allows a choice of seven reproducing characteristics to fit all standard recording systems. An overall frequency response to better than 10000 cycles is available on the wide range settings of this selector. The Transcription

Turntable occupies a space 22-1/2 inches by 21 inches and stands approximately 33 inches above the floor level. The transcription reproduction equipment may be placed in either the control-announce booth or either of the studios without electrical change.

The Type 25B Speech Input Equipment needs no mounting other than the leg units furnished with the unit. The power supply can be mounted in any convenient position provided a reasonable physical separation is maintained between it and the console unit.

Up to seven remote pickup lines pre-equalized by the local telephone company may be terminated directly to the equipment. Three of these remote lines are terminated to the inputs of the line coils and keys. The other four lines are available by means of patching. Suggested additional equipment for Jack Panel and Line Equipment will be found under List 1A.

Microphone plugs and wall receptacles are furnished. One thousand feet of shielded twisted pair wire is supplied for making all audio connections. Power wiring and conduit, junction and outlet are to be furnished and installed by the customer.

Drawings 7423841 and 7423839 show a typical studio layout based upon the equipment furnished by List 1.

Bill of Materials for List 1

Drawing List
7423841
7423839

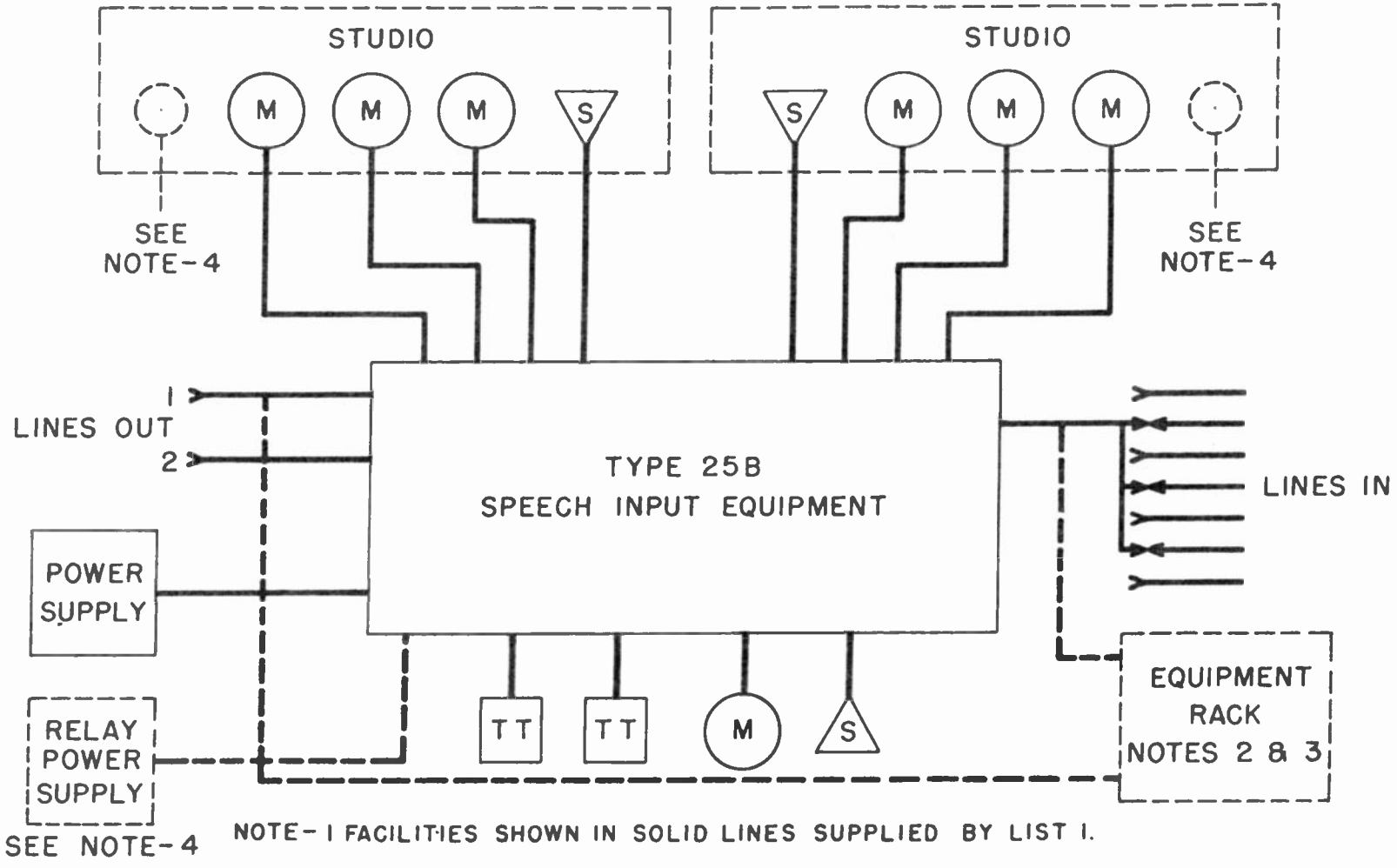
BILL OF MATERIALS

LIST 1

BASIC AUDIO EQUIPMENT

	ITEM	SUPPLIER'S NUMBER	SUPPLIER	AMOUNT
1.	Speech Input Equipment	W.E. 25B	W.E.	1
2.	Vacuum Tube	RCA 1603	RCA	6
3.	Vacuum Tube	W.E. 348A	W.E.	9
4.	Vacuum Tube	W.E. 349A	W.E.	4
5.	Vacuum Tube	W.E. 351A	W.E.	1
6.	Vacuum Tube	W.E. 313C	W.E.	1
7.	Vacuum Tube	W.E. 300B	W.E.	1
8.	Vacuum Tube (Items 2 thru 8 tubes for 25B)	W.E. 274A	W.E.	2
9.	Transcription Turntable	Presto 63B	Presto	2
10.	Cardioid Microphone (For Use in Studio)	W.E. 639A	W.E.	4
11.	Transmitter Mounting	W.E. 22A	W.E.	6
12.	Jack	W.E. 442A	W.E.	4
13.	Adapter	W.E. 712A	W.E.	4
14.	Adapter	W.E. 713A	W.E.	4
15.	Transmitter Attachment	W.E. 11A	W.E.	4
16.	Floor Stand Weights (Items 11 thru 16 mount Items 10)	W.E. KS-764305-2	W.E.	6
17.	Dynamic Microphone (For use in studios and announce booth)	W.E. 633A	W.E.	3
18.	Table Stand	W.E. 23A	W.E.	1
19.	Swivel Joint	W.E. 9A	W.E.	3
20.	Baffle (Items 18 thru 20 mount Item 17)	W.E. 8B	W.E.	3

21.	Cordage	W.E. KS-7133	W.E.	350'
22.	Loud Speaking Telephone (For use in Studios)	W.E. 751B	W.E.	2
23.	Loud Speaking Telephone (For use in control-announce booth)	W.E. 753A	W.E.	1
24.	Panel Receptacles	Cannon P3-13	Cannon	7
25.	Cord Plugs (Microphone plugs and receptacles)	Cannon P3-CG-12	Cannon	7
26.	Headset (For monitoring)	W.E. 1002-C	W.E.	1
27.	Patch Cords	W.E. 2P13A	W.E.	2
28.	Wire (Audio Connections)	W.E. P-357170	W.E.	1000'



NOTE-1 FACILITIES SHOWN IN SOLID LINES SUPPLIED BY LIST I.

NOTE-2 FOR LINE INPUT AND JACK PANEL EQUIPMENT SEE LIST IA.

NOTE-3 FOR STUDIO MONITORING EQUIPMENT SEE LIST IB.

NOTE-4 FOR STUDIO WARNING LIGHT EQUIPMENT SEE LIST IC.

SIMPLIFIED TWO STUDIO SCHEMATIC

7423839

STUDIO AUDIO FREQUENCY FACILITIES

TYPE 25B SPEECH INPUT EQUIPMENT

The Type 25B Speech Input Equipment is a complete A.C. operated console type broadcast program production unit for amplification, control and monitoring of programs originated by microphones, transcription equipments, remote equipments or equivalent sources. It will provide audio facilities for handling two studios and a control room-announce booth.

The Type 25B Speech Input Equipment has been designed for use in broadcasting systems requiring two separate output channels capable of being operated simultaneously and transmitting different programs without interference. Such an equipment is most convenient for broadcasters originating programs for both FM and AM transmission from the same studios or those who require an additional transmitting channel for network originations or other line feeds while programming a local transmitter with different program material. Any combination of seven input circuits (four pre-amplifiers and three remote lines) may be divided to feed either main amplifier channel and outgoing line.

Mounting and installation have been greatly simplified in the 25B by arranging all equipment in two units. The main unit is housed in a console desk of modern design containing two complete high-quality main amplifier channels, capable of simultaneous operation on different programs without interference or crosstalk. Also in this desk console are pre-amplifiers, mixers, switching, indicating, monitoring, cue feeding and

other control apparatus, arranged and coordinated to provide maximum operating flexibility and convenience. A compact power supply unit serves the Type 25B Equipment. This is arranged for wall mounting and is generally located away from the console. The power supply unit, mounted on a swinging frame for easy inspection and maintenance access, contains the power supply units for plate and filament power to all vacuum tubes and also for the loudspeaker cut-off relays.

The operating controls of the main unit are located on the sloping face of a cabinet at the rear of the desk. The nine volume controls, namely, Line Mix 1, 2 and 3, Microphone Mix 1, 2, 3 and 4 and the Master Gain Controls for channels 1 and 2, are located on a small panel that projects from the lower central portion of the cabinet. On the top of this projection are placed 16 lever keys, which control the preamplifier input source, the mixer output connections and the line change-over keys for both channels. Located on the main cabinet face and protected by the mixer control turret are located 40 jacks comprising the input jack field. Terminating on this jack field are seven remote lines, and three utility input circuits together with both input circuits of the three line keys. Four sets of double jacks remain open for use as desired by the customer. A similar panel on the right side of the mixer turret contains two headphone jacks for monitoring each channel, fourteen signal lamps for channel "On" indication, master control or recording signals and twenty two blank spaces that can be used to mount special jacks, pushbuttons or keys, signals, etc.

In the top central portion of the control cabinet are located two illuminated volume indicators. These volume indicators are connected to each output channel through a key controlled pad system that allows a rapid choice of three indicated output levels. Both volume indicators are of

the standard type and read in volume units above a zero level of .001 watt. On the left of the volume indicators are located the talkback keys, the line cue-mix keys and a plate current meter which reads plate currents of all tubes by means of a rotary switch. On the right of the volume indicators are the mixer bus-channel control keys, line cue keys, monitor changeover key, audition changeover key and the monitor amplifier and audition gain control.

The eight microphone or low level transcription input circuits are provided with switching keys for ready selection of either of two low level inputs for each of the four preamplifiers supplied. These are shown diagrammatically in the schematic drawing 7425855. Four of these circuits can be used simultaneously on either channel amplifier, with four in reserve available at a moments notice, enabling the engineer to schedule programs of eight sources, or to dispatch two successive four-source programs. Three additional microphone or transcription sources can be introduced simultaneously with the above sources through the use of external preamplifiers and the line mixers. List 1 does not furnish external preamplifiers for this purpose.

The two main amplifiers are capable of simultaneous operation on separate programs, permitting concurrent dispatch of audio signals to each of two transmitters or out-going lines with each channel being governed by a separate master gain control for adjusting overall levels. Either of these two channels may be fed to either or both of two out-going lines.

Three remote line input-circuits with repeating coils feed incoming line programs to three separate line mixer-controls. Rapid selection of remote or network programs is afforded by three remote line switching keys usable in selecting any one of three lines, for monitoring incoming programs or for connecting to the associated mixer input. Patching jacks, with

which four additional remote lines can be substituted on a line for line basis, make a total of seven lines available. Each of the line mixer inputs is provided with a transfer key which will allow an external utility circuit to be switched in place of a line program source.

The seven mixer potentiometers operate on either of the two main amplifier channels through a seven channel mixer circuit with individual mixer transfer keys for association with either main channel input.

A built-in monitor which may be connected to either main channel is included for aural monitoring. This monitor amplifier is arranged to feed cue programs into studio speakers or to remote line circuits. Operation of a loudspeaker in the same studio with a live microphone is automatically prevented by loudspeaker cutoff relays for the booth and two studios. Contacts are provided on the microphone keys for the operation of studio warning signs.

A switching key is provided to feed the output of either main channel to a separate gain control for feeding external amplifier systems such as house monitors or sound reinforcement.

Normal operation of the tubes can be easily checked by a plate current meter and a rotary tap switch built into the equipment.

The power unit is separate and is designed for wall mounting. It is approximately 15 inches high, 28 inches wide and 10 inches deep. It contains the power supply units for plate and filament power to all vacuum tubes and is intended for location near the main unit, but separate from it. Louvres are provided for ventilation and the equipment is mounted on a swinging frame which allows easy access for inspection and maintenance. Power supply is also incorporated for operation of the loudspeaker relays.

The maximum net gain from low level input to output line terminals is approximately 100 db and from line input to output line terminals is

approximately 36 db. Normal output program level to an outgoing line is +8 VU. The gain frequency response of the main program channels from microphone terminals to output line terminals is within 1 db of the 1000 cycle value from 50 to 15000 cycles with a single frequency output of + 18 dbm (0 db = .001 watt) and with a net gain of 68 db. With the same gain, the harmonic distortion is less than 1% for fundamental frequencies from 50 to 7500 cycles, and the unweighted output noise with microphone terminals terminated with a 30 ohm resistance is not higher than 75 db below + 18 dbm. Connected as furnished, the maximum output level of the monitoring amplifier for + 18 dbm output to an output line for either main amplifier is 3.2 watts in a 2.67 ohm load. At 3.2 watts single frequency output, the harmonic distortion for fundamental frequencies from 50 to 7500 cycles is less than 1%. The unweighted output noise is at least 50 db below .001 watt.

The main unit is an assembly of three units which are shipped separately. They are the console unit (which contains the operating equipment and wiring), the table top unit (which is a flat table top covered on the top and exposed edges with blue formica sheet and cut out to fit the console unit) and the leg units (two of which are required to support the console unit).

The main console has an overall height of 36 inches and a width of 55-1/4 inches. Overall depth if 28-1/4 inches, of which only 13-1/2 inches at the rear is the control cabinet. The table top stands 27-1/2 inches from the floor.

The Type 25B Speech Input Equipment operates from a primary power source of 105-125 volts 60 cycle AC and requires approximately 250 watts.

The following vacuum tubes comprise one set normally required for operation of the 25B Speech Input Equipment.

Type	Console	Power Unit	Total
RCA 1603	6	-	6
WE 348A	8	1	9
WE 349A	4	-	4
WE 351A	-	1	1
WE 313C	-	1	1
WE 300B	-	1	1
WE 274A	-	2	2

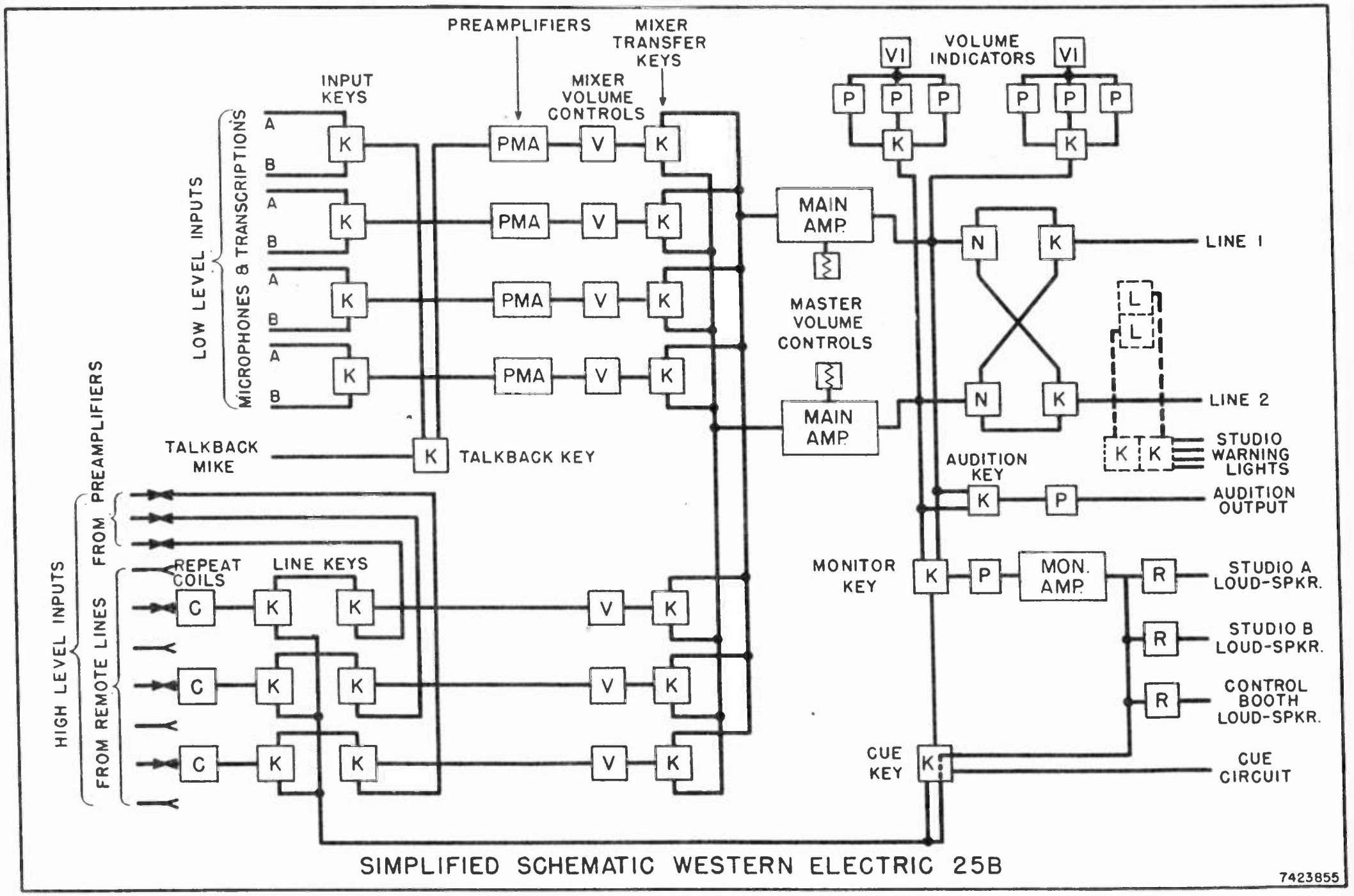
(Where the above recommended tubes are not available, the following types may be substituted.)

Recommended	Substitute
RCA 1603	RCA 6C6 or 77
WE 348A	RCA 6J7G or 6J7
WE 349A	RCA 6F6G or 6F6
WE 351A	RCA 6X5G or 6X5
WE 313C	None
WE 300B	RCA 2A3
WE 274.	RCA 523

The console unit is hinged at its rear edge and may be tilted back to expose the terminal strips and amplifiers which are mounted in a well below the table top surface. This well in turn is hinged and may be released and swung under the table for maintenance and repair. Ventilation louvres are provided. Conduit knockouts at convenient locations in all units makes for easy installation in any position.

No installation materials are furnished with the Type 25B Speech Input Equipment. Power leads are normally installed in either rigid or flexible conduit with standard wires and cables to be obtained and installed by the customer.

Simplified Schematic of Type 25B Speech Input Equipment. 7423855



SIMPLIFIED SCHEMATIC WESTERN ELECTRIC 25B

7423855

STUDIO AUDIO FREQUENCY EQUIPMENT

LIST 1A

LINE INPUT AND JACK PANEL EQUIPMENT

To provide overall operating efficiency, not obtainable when all connections are made by soldering on a terminal block, it is customary to provide a jack panel which is installed in such a manner that circuits can be temporarily connected by means of jack and patch cords. The equipment of this list is recommended as a basic jack panel and line input rack.

Small racks and cabinets are available to support and enclose the line equipment and are large enough to contain the basic equipment. However their use is not recommended due to the fact that any future expansion causes them to be removed and discarded as being too small. Room for expansion of line and monitoring facilities is provided by a standard 77 inch rack such as the Type "C" Cabinet Rack.

It is suggested that the rack mounting space be divided as proposed in Drawing 7423565.

Two Type 222A 15 Jack Mountings are mounted in Space 1. These jack mountings each contain 48 Type 218A Jacks. As all patching is accomplished with double plug cords, this allows termination of 24 circuits on each mounting or 48 circuits on the jack field. Input lines from the Type 25B Equipment are "normalled" through these jacks to the incoming remote lines and three double patch cords are furnished for making temporary patches or connections to other sources. The Jack Mountings are

supplied with facing mats to cover all exposed raw edges.

Incoming network lines are ordinarily pre-equalized by the local telephone company to deliver a fixed frequency response and require no further treatment. However, remote pickup lines within the local toll area can generally be obtained with or without equalization. It is customary for most broadcasting stations to lease "bare" or unequalized lines within these areas because of economic considerations. These lines can then be equalized by the broadcaster to the response required by the program material. In many cases a single line is used as a program line and as a communications line both before and after the program. In these cases it is more convenient if the broadcaster has control of the line equalization. Any equalization loss may be removed for communications use and replaced for program use. A single equalizer may be used for equalizing a number of telephone lines by switching or patching.

To allow equalization of telephone lines up to ten miles in length to a frequency response within plus or minus 1 db from 35 to 8000 cycles, a Type 279A Equalizer Panel is mounted in Space 3. This adjustable equalizer may be patched to any of the program lines and the equalization and program level quickly adjusted to meet the characteristics of the line.

Space 2 is covered with a blank panel and it is proposed to reserve this space for future jack field requirements.

Spaces 4, 5 and 6 are covered with blank panels. These panels are chosen of such a size that it is necessary only to discard a single panel when installing new equipment.

Terminal strips for both high and low level audio frequency and power termination are located behind Space 9.

Spaces 7 and 8 are filled with blank panels.

A corner trim covers mounting hardware and screws and gives the rack a finished appearance.

Cabinet rack and panels are finished in two tone Grey. Base dimensions of the cabinet rack are width 22 inches and depth 18 inches.

If the transmitter is located within the control room, the various unused portions of the rack space can be used to mount the necessary equipment. No equipment of this kind is supplied by List 1A.

Suggestions for the placement of racks are shown on the proposed studio layout drawings.

Bill of Materials for List 1A

Drawing List

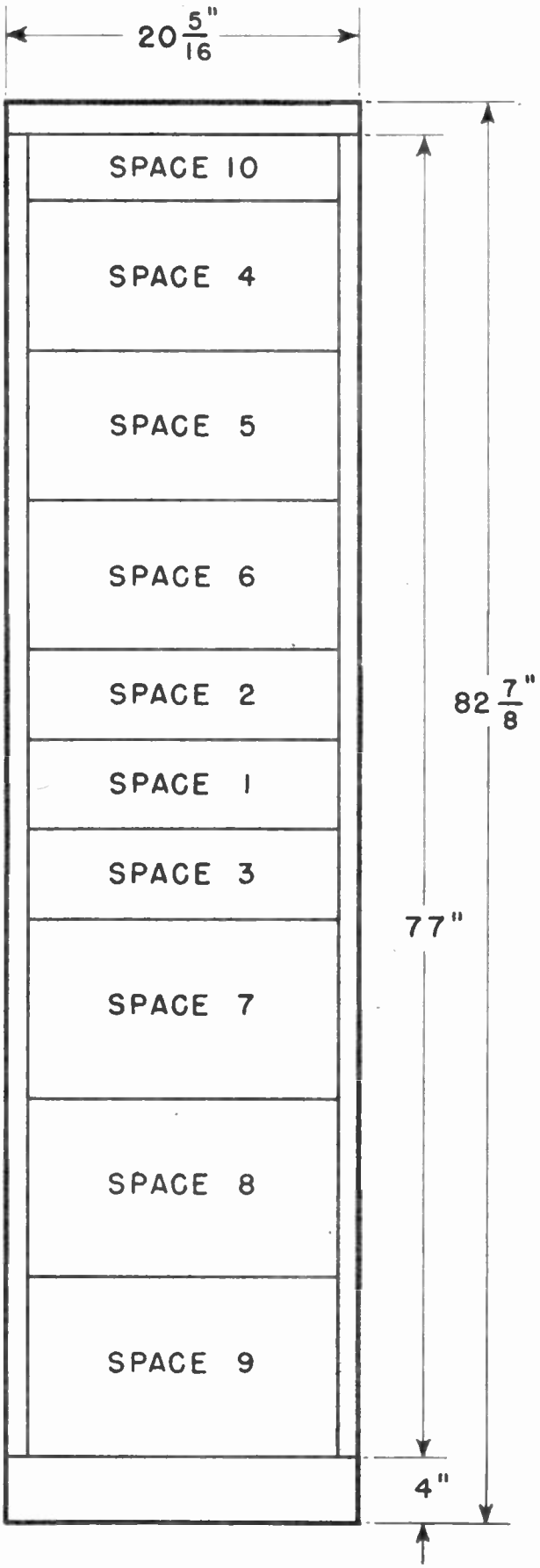
7423565

BILL OF MATERIALS

LIST 1A

LINE INPUT AND JACK PANEL EQUIPMENT

	ITEM	SUPPLIER'S NUMBER	SUPPLIER	AMOUNT
1.	Rack	Par-Metal G-2219	Par-Metal	1
2.	Blank Panel	Par-Metal G-6601	Par-Metal	1
3.	Blank Panel	Par-Metal G-6602	Par-Metal	2
4.	Blank Panel	Par-Metal G-6603	Par-Metal	7
5.	Jack Mounting	W.E. 222A15	W.E.	2
6.	Jacks	W.E. 218A	W.E.	96
7.	Patch Cords	W.E. 2P13A	W.E.	3
8.	Equalizer Panel	W.E. 279A15	W.E.	1
9.	Terminal Strip (Audio)	W.E. 100B	W.E.	3
10.	Terminal Block (Power)	Westinghouse S-122437	Westinghouse	1
11.	List 1			1



SUGGESTED RACK LAYOUT

7423565

STUDIO AUDIO FREQUENCY FACILITIES

LIST 1B

STUDIO MONITORING EQUIPMENT

The Type 25B Speech Input Equipment provides monitoring facilities for three loudspeakers only. Usually these loudspeakers are located in the control room and in the studios. Ordinarily there are other points within the studios requiring monitoring loudspeakers such as foyers and offices. It is the purpose of List 1B to suggest combinations of monitoring equipment for any studio.

The Bill of Materials is based on one Type 124E Monitoring Amplifier. The Type 124E Monitoring Amplifier is a two stage 12 watt output power amplifier, having a bridging gain of 50 db. and a matching gain of 63 db. The amplifiers frequency response is uniform over a range of 30 to 15000 cycles and it has a noise level of approximately -37 db. relative to .001 watt at full gain. The input of the monitoring amplifier is connected to the audition terminals of the Type 25B Equipment. This allows the monitoring system to be fed from either main program channel through the audition changeover switch and its gain to be controlled from the front panel of the Speech Input Equipment. If a single Type 125E Amplifier is connected to the audition terminals, its input circuit should be connected to the bridging position.

The output of the Type 124E Amplifier can be used to feed program to either a group of 3 Type 753 Speakers or 6 Type 751 Speakers. Choice of loudspeaker combinations should be made from Items 3 or 3A in the Bill of Materials of this list.

The combination of speakers is given here as a suggestion only. Owing to volume level tolerances and to impedance matching schemes it is impossible to list a Bill of Materials to cover all possible speaker combinations. In general it will be found desirable to use the Type 753 Loudspeakers where high level, high quality, monitoring is necessary and the Type 751 Loudspeakers for routine listening or cue purposes where lower volume and quality standards are acceptable.

The Type 124E Amplifier mounts on a standard relay rack panel which can be mounted in either Space 4, 5 or 6 of the equipment rack. See List 1A.

For an output power of 12 watts the following tube complement is used in the 124E Amplifier.

2 - RCA 6J7

2 - RCA 6L6

1 - RCA 5T4

For an output power of 20 watts the internal connections of the amplifier are changed slightly and the following complement of Western Electric tubes are used.

2 - W.E. 348A

2 - W.E. 350B

1 - W.E. 274B

Bill of Materials for List 1B.

BILL OF MATERIALS

LIST 1B

STUDIO MONITORING EQUIPMENT

	ITEM	SUPPLIER'S NUMBER	SUPPLIER	AMOUNT
1.	Amplifier	W.E. 124E-15	W.E.	1
2.	Tube Kit for 12 watt output (RCA)			
		RCA 6J7	RCA	2
		RCA 6L6	RCA	2
		RCA 5T4	RCA	1
	or			
2A.	Tube Kit for 20 watt output (W.E.)			
		W.E. 348A	W.E.	2
		W.E. 350B	W.E.	2
		W.E. 274B	W.E	1
3.	Loudspeaking Telephone	W.E. 753C	W.E.	3
	or			
3A.	Loudspeaking Telephone	W.E. 751B	W.E.	6
4.	List 1			1
5.	List 1A			1

STUDIO AUDIO FREQUENCY FACILITIES

LIST 1C

STUDIO WARNING LIGHT EQUIPMENT

To provide a visual indication of open microphones in the studio it is customary to provide an "On Air" sign in each studio. These signs are usually made of a framed pane of colored glass with the words "On Air" painted on and illuminated from the rear by small lamp. The Type 25B Speech Input Equipment is provided with key contacts for the operation of such indicators. Each studio warning light is operated by a single relay which switches the 110 volt line current for a small bulb to illuminate the sign. Relays and mounting brackets are furnished by this list and can usually be mounted within the same cabinet used to contain the sign. Power for the operation of these relays is furnished by a Type KS-7593 Rectifier. All cabinets for mounting signs and relays, signs and electrical wiring are to be furnished by the customer.

BILL OF MATERIALS

LIST 1C

STUDIO WARNING LIGHT EQUIPMENT

	ITEM	SUPPLIER'S NUMBER	SUPPLIER	AMOUNT
1.	Rectifier	W.E. KS-7593	W.E.	1
2.	Relay	W.E. E-31	W.E.	*
3.	Relay Mounting Plate	W.E. 677AB	W.E.	*

* One each of Items 2 and 3 are required for each studio warning light to be operated.

STUDIO AUDIO FREQUENCY EQUIPMENT

LIST 2

MULTISTUDIO EQUIPMENT

A Studio Equipment layout to provide the maximum broadcasting facilities for single or two station use is suggested by List 2. The layout is based upon a single Type 25B Studio Input Equipment and is arranged to provide facilities for two talent studios and an announce booth. In addition to these facilities, microphone inputs are provided in an adjoining room to each studio and in the control room. The provision of microphone outlets in the small rooms adjacent to the studios allow their use as observation booths, client rooms or emergency studios for peak programming periods. The microphone position assigned to the control room is for the purpose of making network breaks or announcements when operating two stations simultaneously.

To enable full operation without interference the following input transfer key assignments are made. Position 1 of Preamplifier 1 is connected to Microphone 2 in Studio 1. Position 2 of Preamplifier 1 is connected to Microphone 2 in Studio 2. Position 1 of Preamplifier 2 is connected to Microphone 1 in Studio 1. Position 2 of Preamplifier 2 is connected to Transcription Turntable 1. Position 1 of Preamplifier 3 is connected to Transcription Turntable 2. Position 2 of Preamplifier 3 is connected to Microphone 1 in Studio 2. Position 1 of Preamplifier 4 is connected to the control room microphone. Position 2 of Preamplifier 4 is connected to the announce booth microphone. The control room microphone is also connected to the talkback input terminals and the short circuiting

contacts for the program circuits are removed from the back position of the talkback key. This allows the control room microphone to be placed in circuit with Preamplifier 1 and permits simultaneous use of both announce booth and control room microphones.

The microphone outlets for the combination observation booth studios are permanently installed and paralleled with the studio Number 2 microphone psotions. An auxiliary relay operated by a switch located on the right jack field of the console allows the loudspeaker to be muted before the microphone is connected. The control room speaker is interlocked into the microphone keys by the use of a similar relay. Both the control room and observation booth studio loudspeakers are fed from the house monitor system. The loudspeaker outlets supplied by the Type 25B Speech Input Equipment are assigned to the two talent studios and the announce booth.

Simplified schematic drawings and typical studio layout schemes are shown by Drawings 7423838 and 7423840.

Bill of Materials for List 2

Drawing List

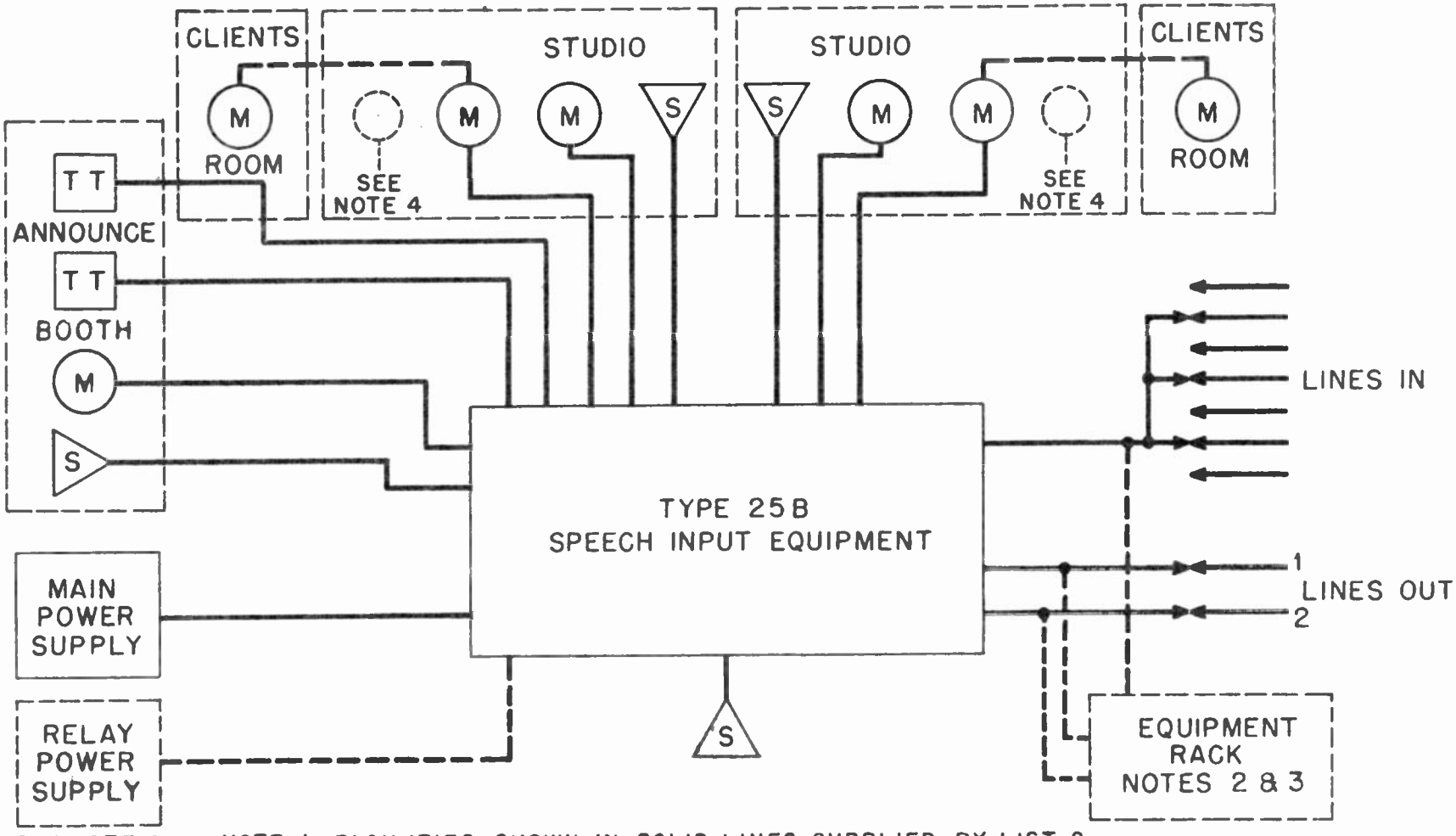
7423838
7423840

BILL OF MATERIALS

LIST 2

MULTISTUDIO EQUIPMENT

ITEM		SUPPLIER'S NUMBER	SUPPLIER	AMOUNT
1.	Dynamic Microphone (For use in Observation Booth-Studios)	W.E. 633A	W.E.	2
2.	Table Stand	W.E. 23A	W.E.	2
3.	Swivel Joint (Items 2 and 3 Mount Item 1)	W.E. 9A	W.E.	2
4.	Cordage	W.E. K.S.-7133	W.E.	100 '
5.	Loudspeaking Telephones (For use in Observation Booth and Announce Booth)	W.E. 751B	W.E.	3
6.	Panel Receptacles	Cannon P3-13	Cannon	2
7.	Cord Plugs (Microphone Plugs and Receptacles)	Cannon P3-CG-12	Cannon	2
8.	Relay	W.E. [illegible]-65	W.E.	3
9.	Relay	W.E. E-31	W.E.	3
10.	Relay Mounting Plate (Speaker Muting and Studio Warning Light Relays)	W.E. 677AB	W.E.	3
11.	Key (For Operating Speakers and Warning Lights)	W.E. 498K	W.E.	2
12.	LIST 1			1
13.	LIST 1A			1
14.	LIST 1B			1
15.	LIST 1C			1



NOTE 1-FACILITIES SHOWN IN SOLID LINES SUPPLIED BY LIST 2.

NOTE 2-FOR LINE INPUT AND JACK PANEL EQUIPMENT SEE LIST 1A.

NOTE 3-FOR STUDIO MONITORING EQUIPMENT SEE LIST 1B.

NOTE 4-FOR STUDIO WARNING LIGHT EQUIPMENT SEE LIST 1C.

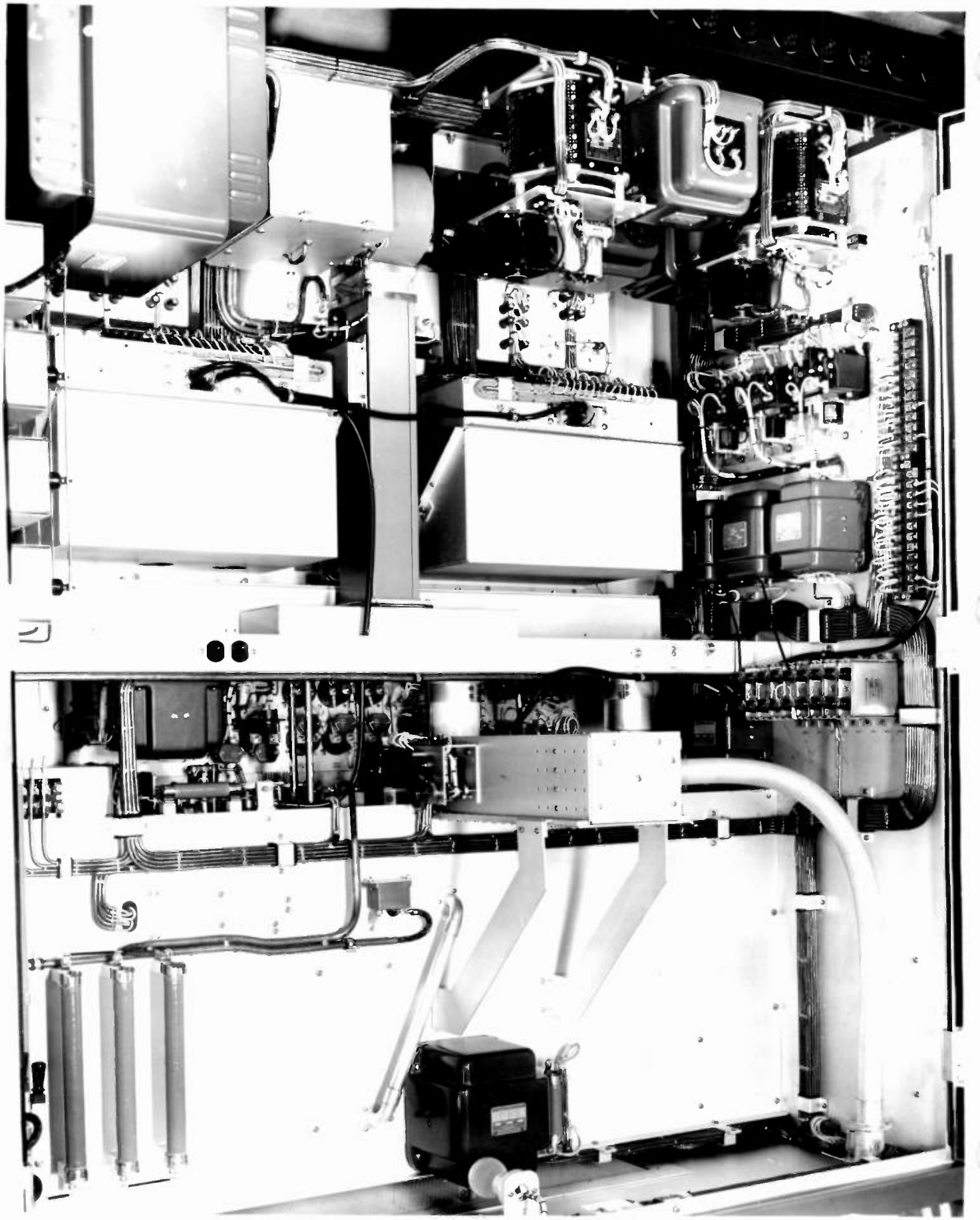
SIMPLIFIED MULTI-STUDIO SCHEMATIC

7423838

PHOTOGRAPHS

The following photographs (c-10904, C-10905 and C-10907) show the type FM-1, 1-KW transmitter now in production and are included to more clearly illustrate the general design and construction features of Westinghouse FM transmitters.

C-10904



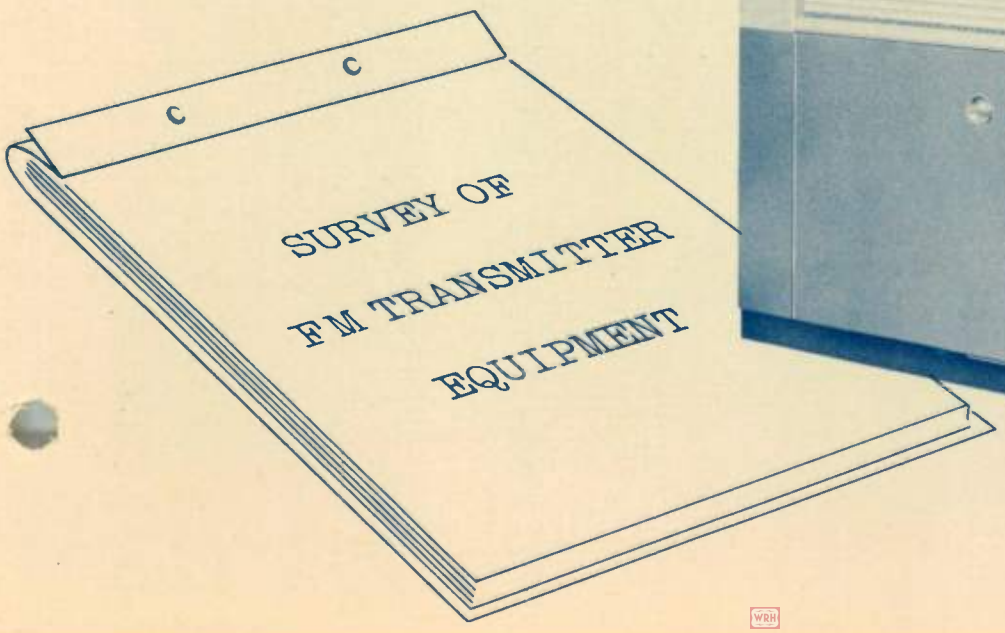
DESCRIPTIVE LEAFLETS

and

SUPPLEMENTARY INFORMATION

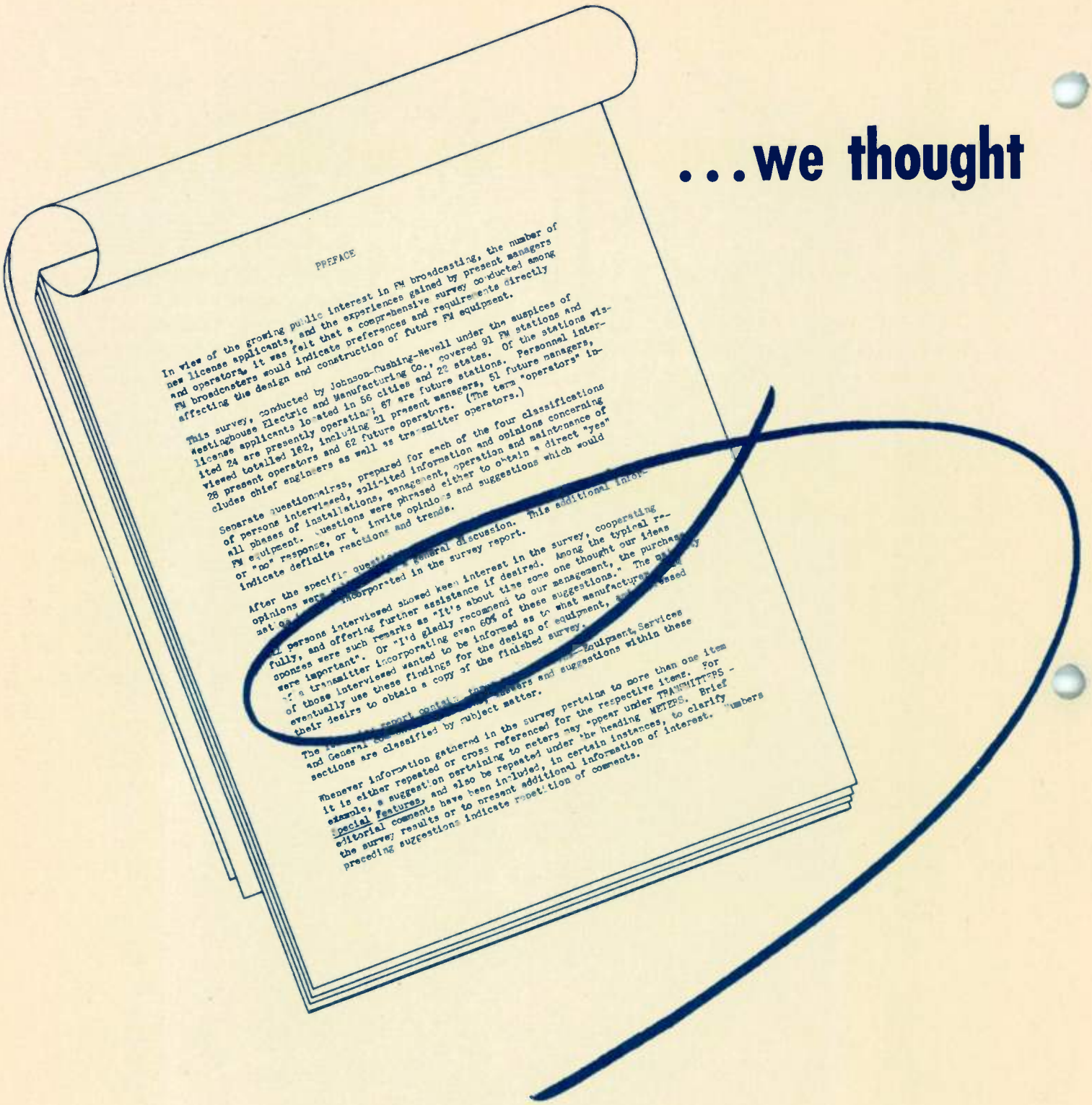
THE OPERATOR'S **fm** TRANSMITTER

designed by you



WESTINGHOUSE

...we thought



PREFACE

In view of the growing public interest in FM broadcasting, the number of new license applicants, and the experiences gained by present managers and operators, it was felt that a comprehensive survey conducted among FM broadcasters would indicate preferences and requirements directly affecting the design and construction of future FM equipment.

This survey, conducted by Johnson-Cushing-Newell under the auspices of Westinghouse Electric and Manufacturing Co., covered 91 FM stations and license applicants located in 56 cities and 22 states. Of the stations visited 24 are presently operating; 67 are future stations. Personnel interviewed totalled 162, including 21 present managers, 51 future managers, 28 present operators and 62 future operators. (The term "operators" includes chief engineers as well as transmitter operators.)

Separate questionnaires, prepared for each of the four classifications of persons interviewed, solicited information and opinions concerning all phases of installations, management, operation and maintenance of FM equipment. Questions were phrased either to obtain a direct "yes" or "no" response, or to invite opinions and suggestions which would indicate definite reactions and trends.

After the specific questions were answered, a general discussion. This additional information was incorporated in the survey report.

All persons interviewed showed keen interest in the survey, cooperating fully, and offering further assistance if desired. Among the typical responses were such remarks as "It's about time some one thought our ideas were important". Or "I'd gladly recommend to our management, the purchasing of a transmitter incorporating even 60% of these suggestions." The general opinion of those interviewed wanted to be informed as to what manufacturers planned to eventually use these findings for the design of equipment, and expressed their desire to obtain a copy of the finished survey.

The report contains many charts and suggestions within these and General Equipment Services sections are classified by subject matter.

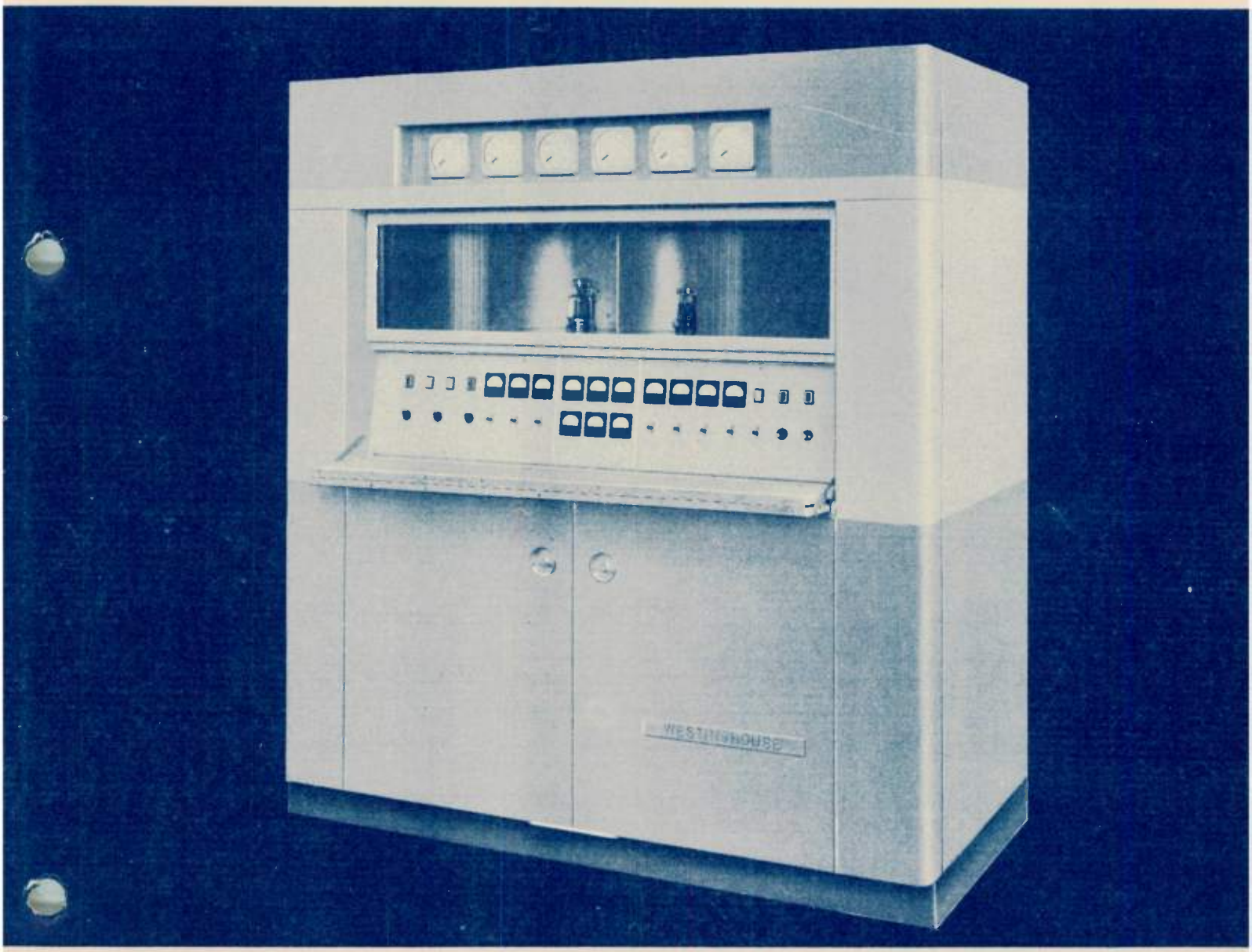
Whenever information gathered in the survey pertains to more than one item it is either repeated or cross referenced for the respective items. For example, a suggestion pertaining to meters may appear under TRANSMITTERS - Special Features, editorial comments have been included, in certain instances, to clarify the survey results or to present additional information of interest. Numbers preceding suggestions indicate repetition of comments.

"It's about time someone thought our ideas were important."

they were so important we put them to work

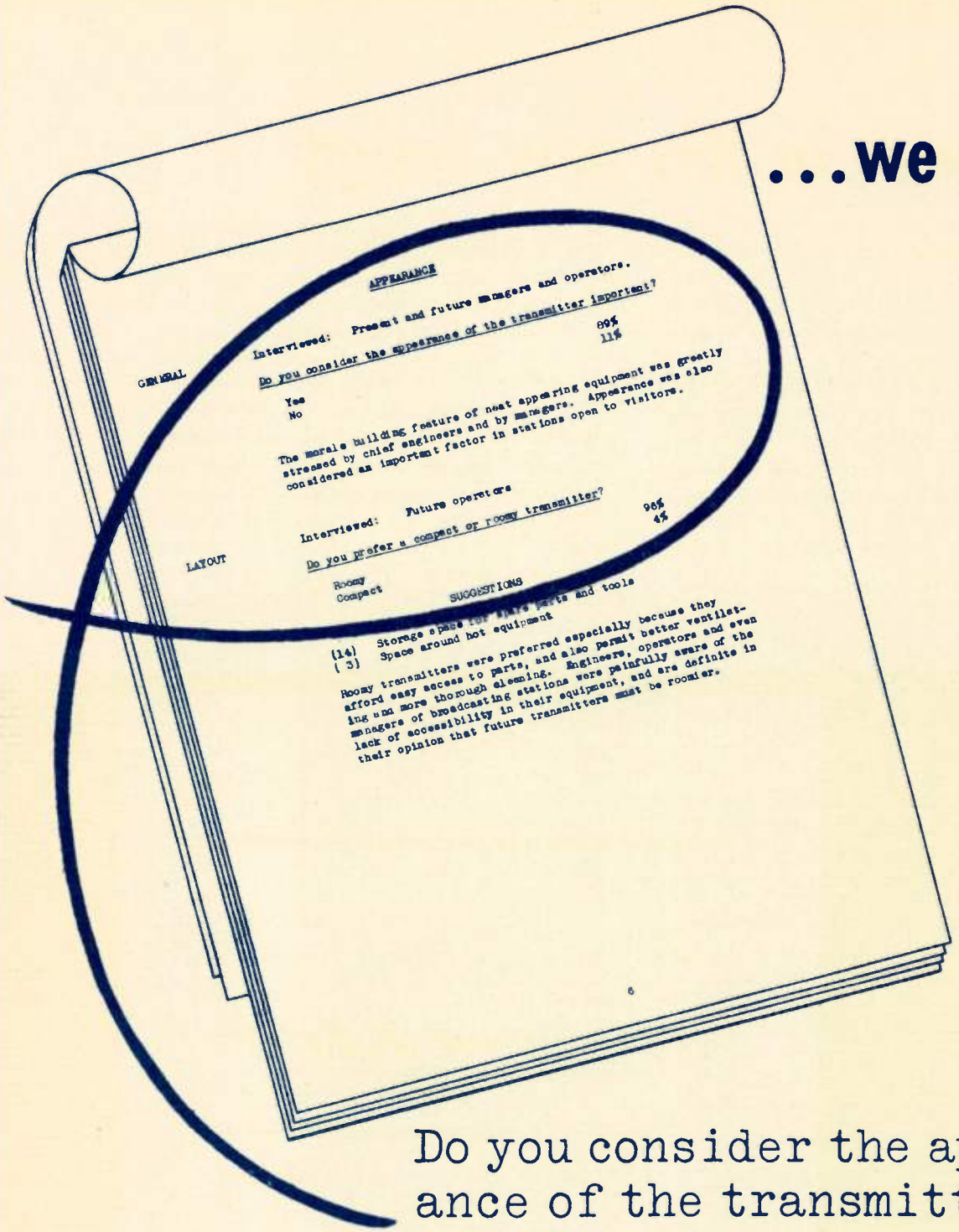
And the result of this extensive survey—162 station managers and operators in 56 cities—is the new 1 and 3-kw FM transmitters by Westinghouse. It's actually an *operator's* transmitter, for its smart styling and advanced design are the products of the ideas of two classes of operators... the ones we interviewed (through an independent, national survey organization) and the Westinghouse engineers who have the actual operating experience of five Westinghouse FM stations.

How well this combination has worked is shown in this booklet . . . photographic evidence of new *operating* ideas in transmitter design.



Centrally-located control panel is easily accessible through door that folds out of the way. Control panel includes power switches; electrically-driven tuning controls and their position indicating instruments; 6 meters in center panel associated

...we wrapped up


APPEARANCE

GENERAL

Interviewed: Present and future managers and operators.

Do you consider the appearance of the transmitter important?

89%
11%

Yes
No

The morale building feature of neat appearing equipment was greatly stressed by chief engineers and by managers. Appearance was also considered an important factor in stations open to visitors.

LAYOUT

Interviewed: Future operators

Do you prefer a compact or roomy transmitter?

96%
4%

Roomy
Compact

SUGGESTIONS

(14) Storage space for spare parts and tools
(3) Space around hot equipment

Roomy transmitters were preferred especially because they afford easy access to parts, and also permit better ventilating and more thorough cleaning. Engineers, operators and even managers of broadcasting stations were painfully aware of the lack of accessibility in their equipment, and are definite in their opinion that future transmitters must be roomier.

Do you consider the appearance of the transmitter important?

Yes . . . 89%
No 11%

Do you prefer a compact or roomy transmitter?

Roomy . . 96%
Compact . . 4%

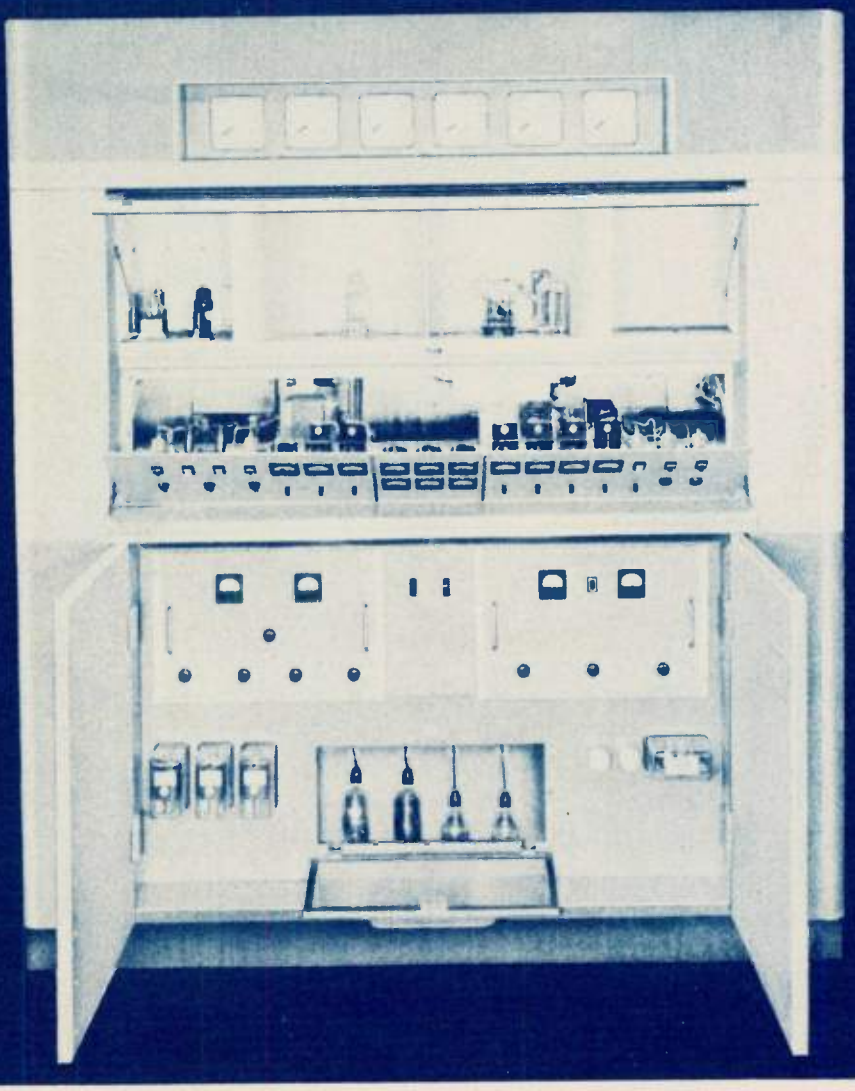
both answers in this new design

This smartly-styled transmitter (in two-tone blue and grey) has an important aid to operators: complete, fast and easy accessibility for servicing. This is so important it gained nearly unanimous opinion in the survey. (See opposite page.)

This new help shows up in many ways: you can reach all tubes quickly from easily-opened front panels (see photograph above); high-voltage rectifier tubes can be checked visually any time through the glass panels; frequency modulated master oscillator unit and the frequency control unit are built on standard relay rack chassis and equipped with plug-in connectors to allow easy removal.

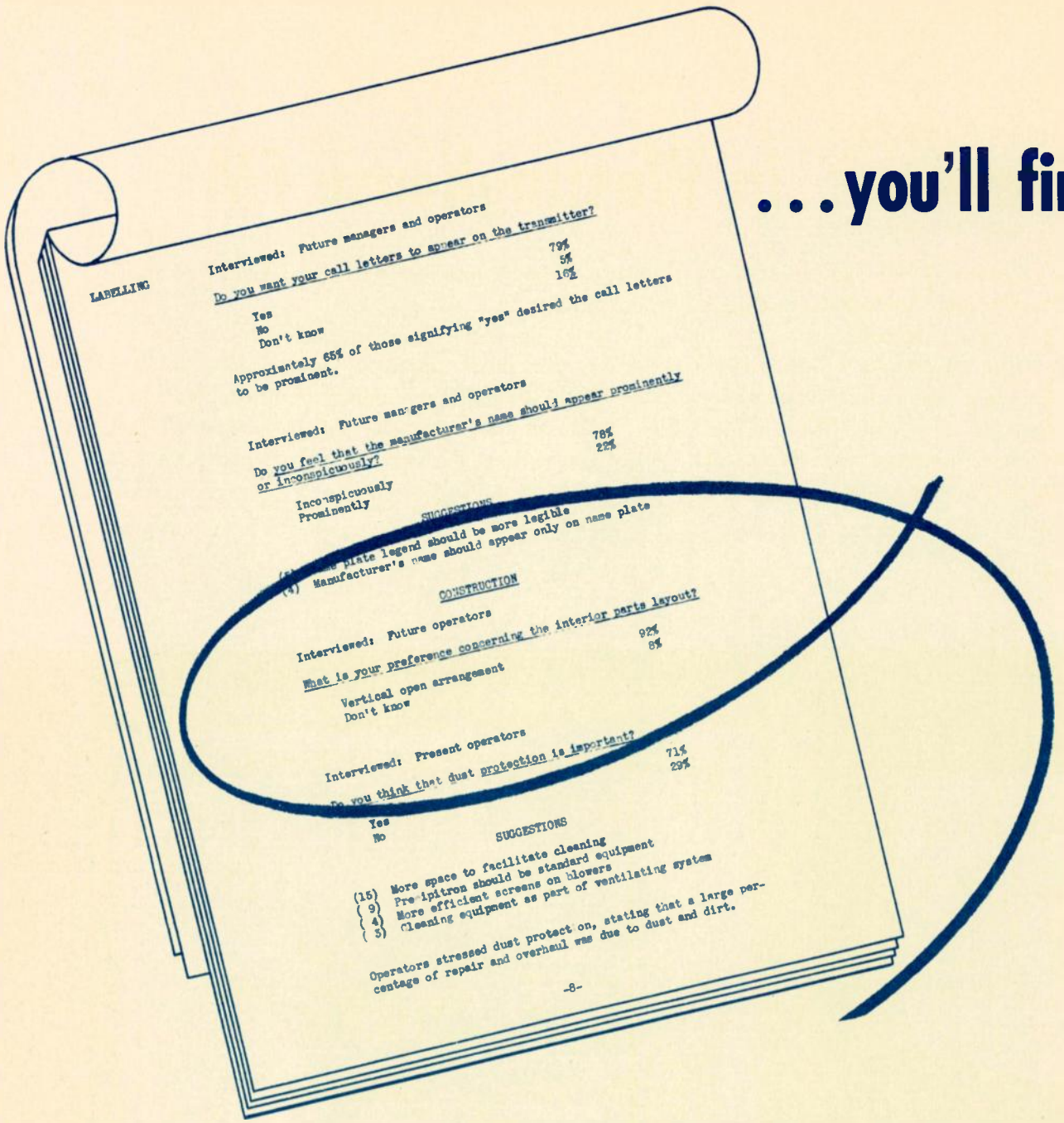
The entire design highlights easy access and plenty of working space. From top to bottom (see photograph) on the front panels are: (1) a hinged window that lifts up and locks in open position, makes it easy to service low-voltage regulator, driver and power amplifier tubes; (2) control-panel door which folds out of the way; and hinged panel comes forward to permit inspection and cleaning; (3) two lower doors open to removable frequency modulated master oscillator and frequency control units, power switches and relays.

Operators have long been painfully aware of poor transmitter designs that created blind corners and cramped working quarters. Here, then, is the solution in a transmitter that gives you what you asked for.



All doors, panels and windows opening to live circuits are equipped with interlocks and grounding switches. Lightweight aluminum cubicle provides excellent shielding at 100 mc. In lower section of cubicle are plug-in frequency modulated master oscillator and frequency control units, low-voltage rectifier tubes and high-voltage rectifier tubes. Relays from left to right are: 250, 400 and 2000-volt overload protection; bias protection for r.f. driver and P.A. tubes, and time delay relay to protect mercury vapor rectifier tubes. All overload protection is fuseless.

...you'll find this



LABELLING

Interviewed: Future managers and operators

Do you want your call letters to appear on the transmitter?

Yes	79%
No	5%
Don't know	16%

Approximately 65% of those signifying "yes" desired the call letters to be prominent.

Interviewed: Future managers and operators

Do you feel that the manufacturer's name should appear prominently or inconspicuously?

Inconspicuously	78%
Prominently	22%

SUGGESTIONS

(2) Name plate legend should be more legible
(4) Manufacturer's name should appear only on name plate

CONSTRUCTION

Interviewed: Future operators

What is your preference concerning the interior parts layout?

Vertical open arrangement	92%
Don't know	8%

Interviewed: Present operators

Do you think that dust protection is important?

Yes	71%
No	29%

SUGGESTIONS

(15) More space to facilitate cleaning
(9) Pre-ipitron should be standard equipment
(4) More efficient screens on blowers
(3) Cleaning equipment as part of ventilating system

Operators stressed dust protect on, stating that a large percentage of repair and overhaul was due to dust and dirt.

-8-

What is your preference concerning the interior parts layout?

Vertical open arrangement 92%
Don't know . . 8%

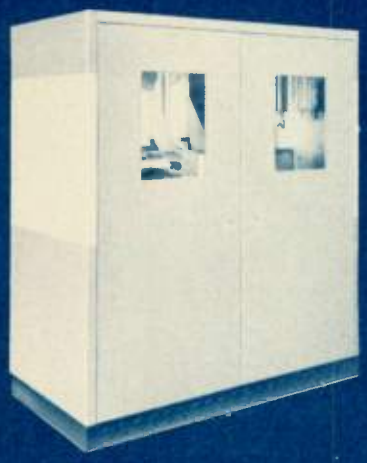
. . . and more . . . in Westinghouse FM

The vertical arrangement already described for the front of Westinghouse transmitters follows through in the easily-serviced rear compartments.

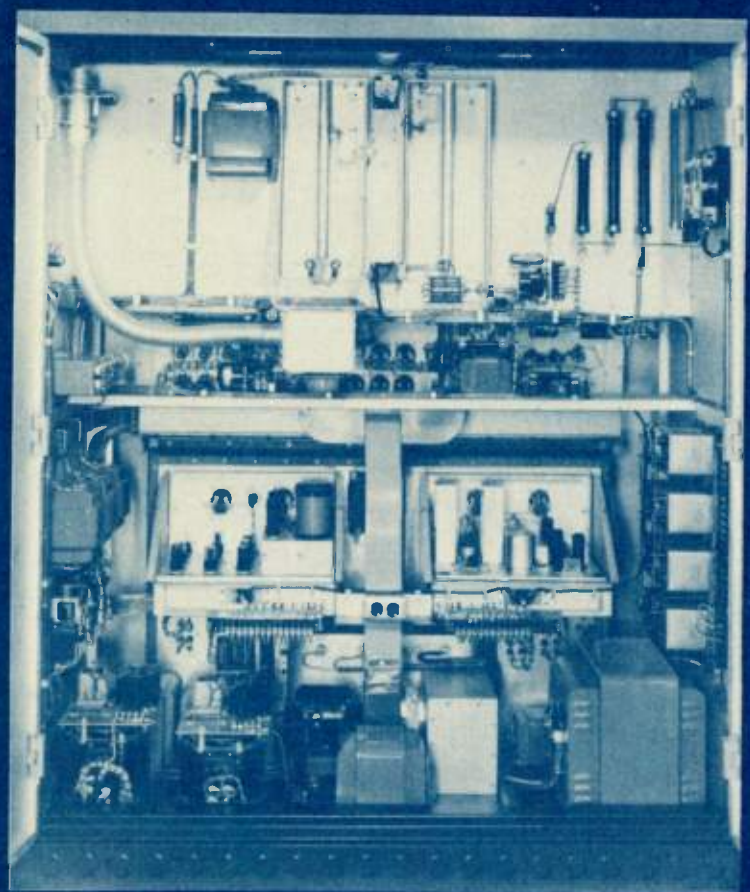
You can see many of these features in the photograph above. In the lower left corner are two motor-driven voltage regulators and immediately to their right is the blower motor and air duct. Dust-tight covers are provided for the plug-in units; and note the two complete crystal oscillator circuits and their plug-in crystals.

On the upper panel, from right to left, are the r.f. driver, concentric line-type tank circuit, variable coupling loop and P.A. concentric cathode line.

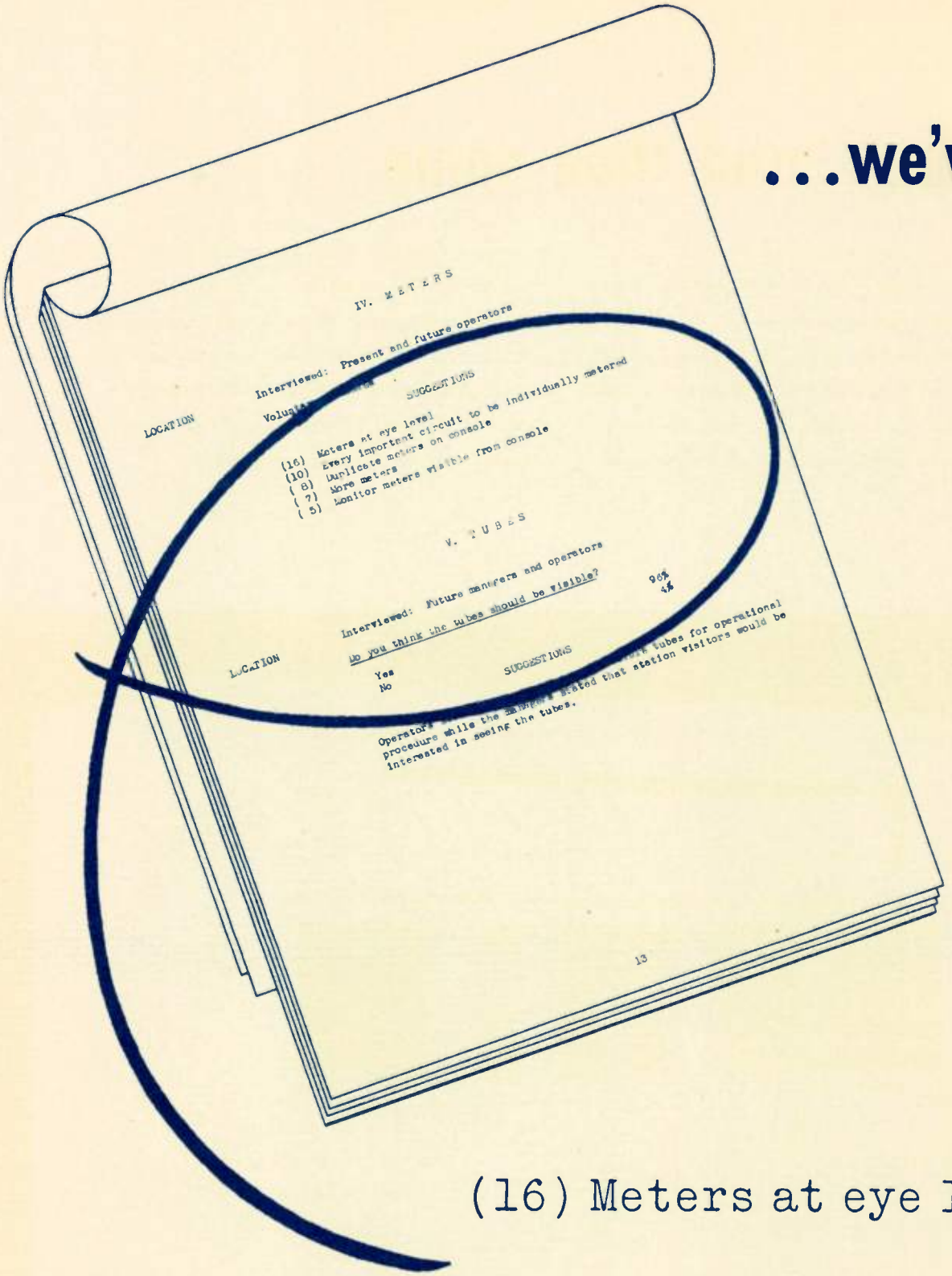
The inside story of new advantages in Westinghouse FM transmitters is backed by even more features that operators want.



Large windows in rear doors permit inspection of interior. Output transmission line (flexible) can be seen through left-hand window and in view at right. Note the convenient power outlet; and lamp for lighting mounted at top of cubicle.



...we've done



IV. M E T E R S

Interviewed: Present and future operators

LOCATION Volun... SUGGESTIONS

(16) Meters at eye level
(10) Every important circuit to be individually metered
(8) Duplicate meters on console
(7) More meters
(5) Monitor meters visible from console

V. T U B E S

Interviewed: Future manuvers and operators

Do you think the tubes should be visible? 96% 4%

LOCATION SUGGESTIONS

Yes
No

Operators ... tubes for operational procedure while the ... stated that station visitors would be interested in seeing the tubes.

13

(16) Meters at eye level

Do you think the tubes should be visible?

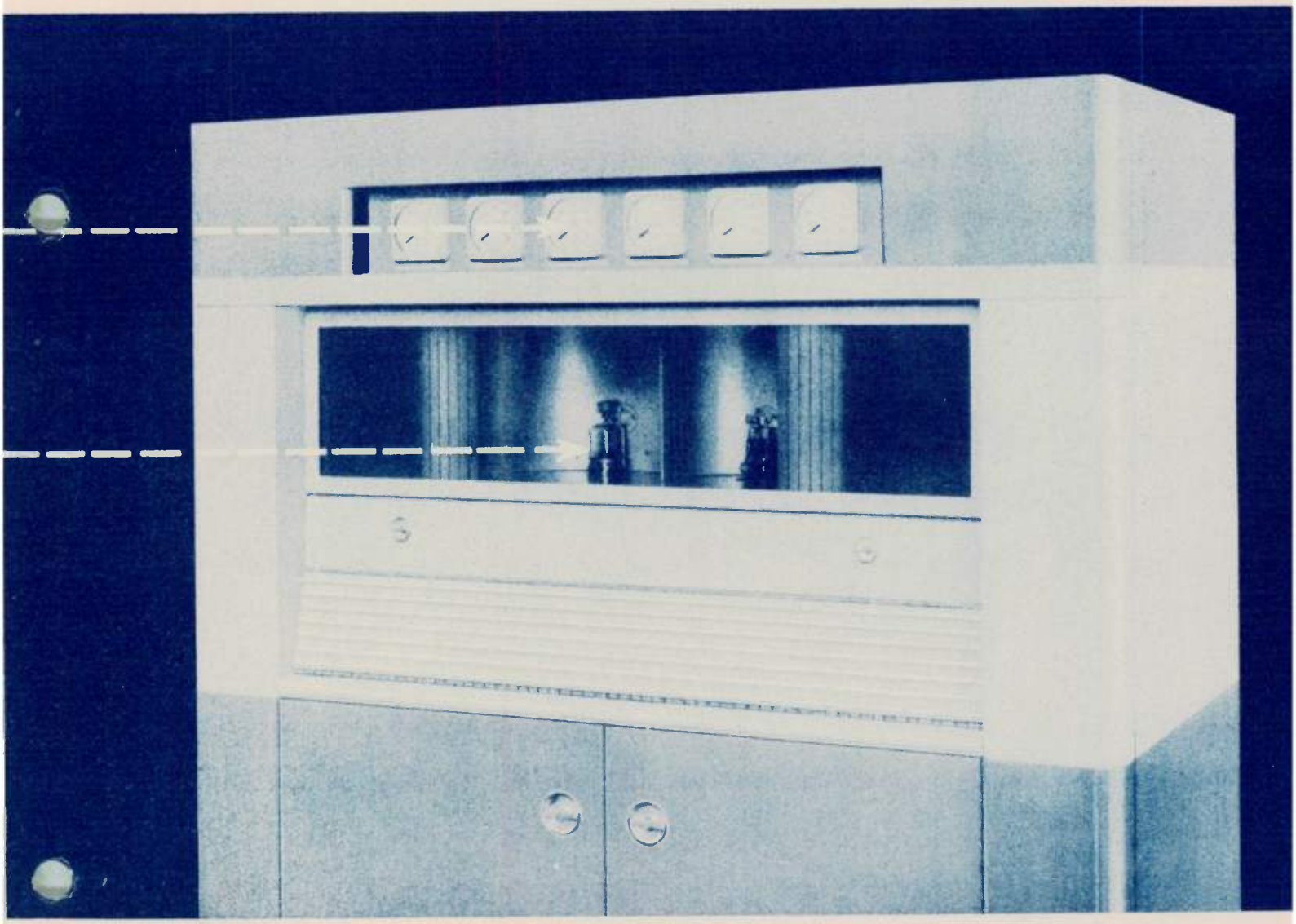
Yes . . . 96%
No 4%

. . . both . . . and then some

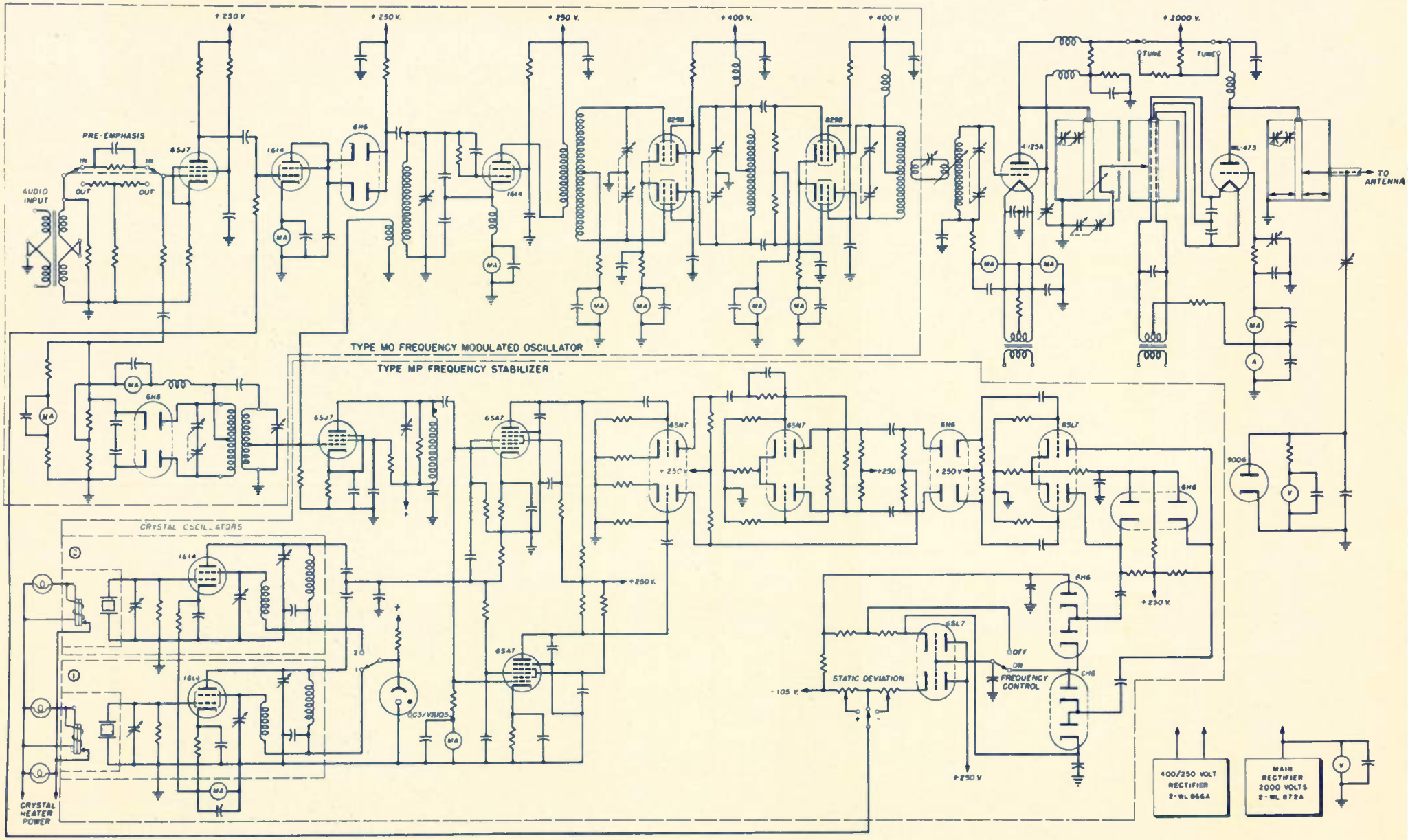
These seemingly minor items rated special attention by operators, as well they should. And Westinghouse incorporated both in the new designs.

But making the job easy is a keynote of the entire construction of these transmitters. To place the transmitter in operation, for example, it is only necessary to connect the audio input, r.f. transmission line and input power supply. You can increase power by adding "building-block" amplifiers.

These mechanical features, of course, are the natural twin of the improved circuits and electrical characteristics of the Westinghouse transmitters. For complete, detailed information about these circuits, ask your nearest Westinghouse office.



Meters (270° non-parallax) are at convenient eye level and r.f. driver and power amplifier tubes are visible through glass window. Both 1 and 3-kw transmitters use same cubicle.



Schematic diagram of 1-kw FM transmitter. In type FM-3 transmitter, the r.f. driver has two type 4-125A tubes, and the power amplifier uses two type WL-473A tubes, both in push-pull, and the h.v. rectifier uses six type WL-872A tubes.

Westinghouse transmission lines and antennas are ready

These Westinghouse FM transmitters will operate into any suitable combination (r.f. output impedance, 40-80 ohms) of r.f. transmission line and antenna within the 88-108 mcs band. The transmission lines are coaxial pressurized for 1, 3 and 10-kw transmitters.

The antenna is a horizontally-polarized turnstile system using folded dipoles. It is equipped to mount a standard 300 mm airways hazard beacon and has facilities for bolting to a supporting tower. The antennas are available with 1, 2, 4, 6 and 8 bays.

Electrical and Mechanical Characteristics of Antennas

Type	No. of Bays	Power Gain	Field Gain	Vertical Dimensions	Weight	Bending Moment
MN-1	1	0.5	0.707	1⅛ in.	360 lbs.	1,190 ft. lbs.
MN-2	2	1.2	1.09	5 ft.	510 lbs.	3,300 ft. lbs.
MN-4	4	2.53	1.58	15 ft.	820 lbs.	8,500 ft. lbs.
MN-6	6	3.85	1.96	25 ft.	1,130 lbs.	17,100 ft. lbs.
MN-8	8	5.2	2.28	35 ft.	1,610 lbs.	28,700 ft. lbs.

Note 1: Bays are spaced one-half wave length apart; approximate vertical dimensions of the radiating portion are given.

Note 2: Bending moments are in accordance with A.I.S.C. standards.

Note 3: Weights given include 300 mm beacon.

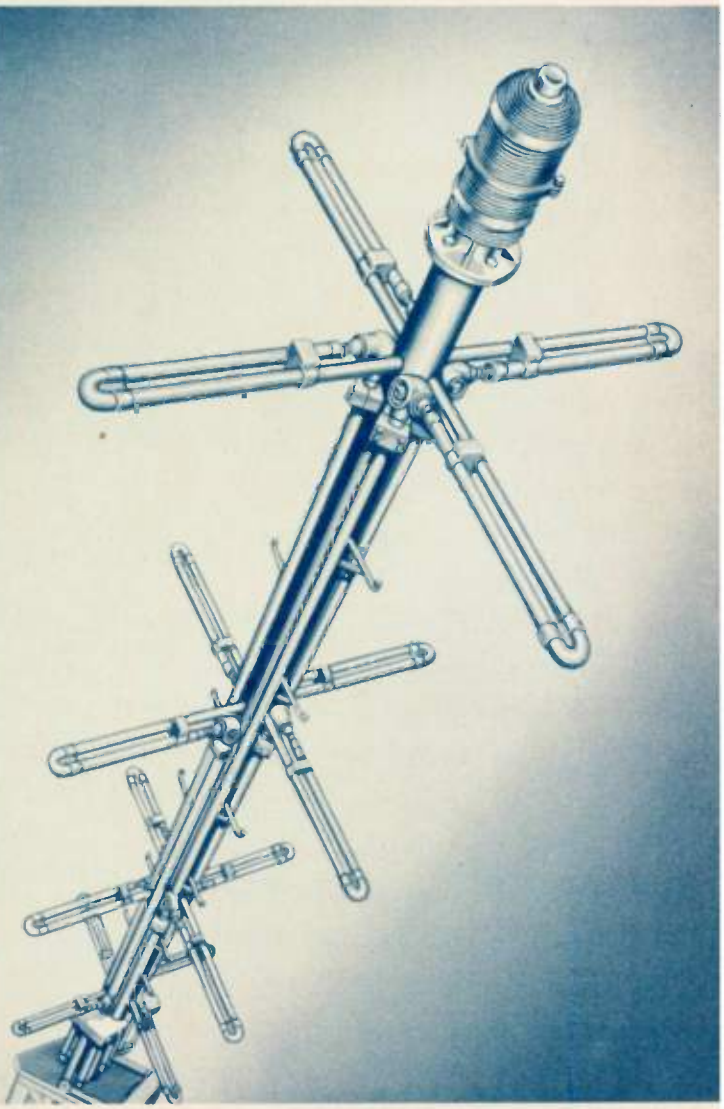
Note 4: Antennas can be supplied with or without sleet melting units. The heater units are installed in the antenna tubing and operate from a 220-volt, single-phase supply.

Electrical and Mechanical Characteristics of Transmission Lines

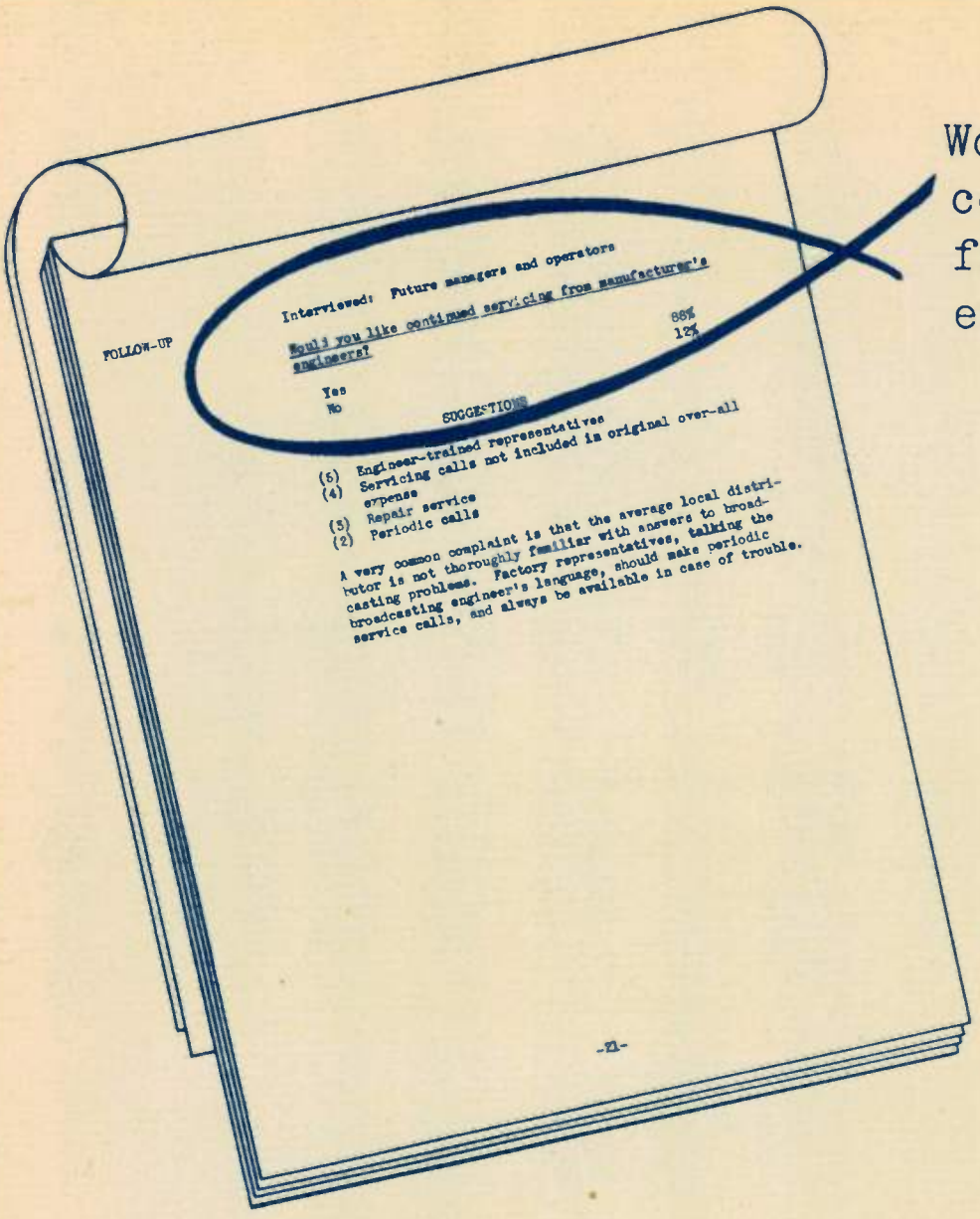
Transmitter Rating	Line Size	Efficiency at 100 mc/s				
		100 ft.	200 ft.	400 ft.	700 ft.	1,000 ft.
1 KW	⅞ in.	90%	81%	65.5%	47.7%	34.7%
3 KW	1⅝ in.	85%	90%	80.5%	68.5%	58.5%
10 KW	3⅛ in.	97%	93.5%	87.5%	79.3%	71.8%

Note 1: Where long lengths of line cause excessive attenuation of power, it may be desirable to select the next larger size line in order to obtain the over-all required efficiency of transmission.

Note 2: Efficiencies given are for inner conductor temperature at 25°C.



Westinghouse type MN-4 antenna. Antennas can be supplied with or without sleet melting units. Heater units are installed in the antenna tubing and operate from a 220-volt, single-phase supply.



Would you like continued servicing from manufacturer's engineers?

Yes . . . 88%
No 12%

You'll get it from Westinghouse

It's part of Westinghouse policy to give you all the help you want.

And you'll get *experienced* help, straight from the engineer's own operating experience at five FM and six AM Westinghouse stations . . . a background unmatched by any other transmitter manufacturer.

Your nearest Westinghouse office is ready now to help you in any phase of FM planning and operation. Westinghouse Electric Corporation, Industrial Electronics Division, Baltimore 3, Maryland.

Electronics at Work

WESTINGHOUSE ELECTRIC CORPORATION · BALTIMORE, MARYLAND

B-3829 7½ M 5-46 WRH Litho. in U.S.A.

THE WESTINGHOUSE 10 KW

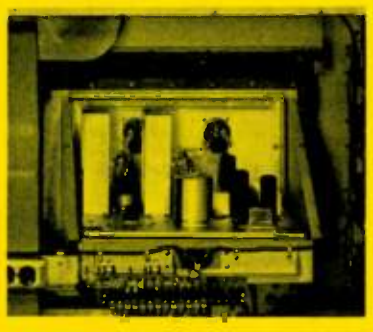
fm

TRANSMITTER

YOU HELPED DESIGN THIS TRANSMITTER FROM THE GROUND UP . . .

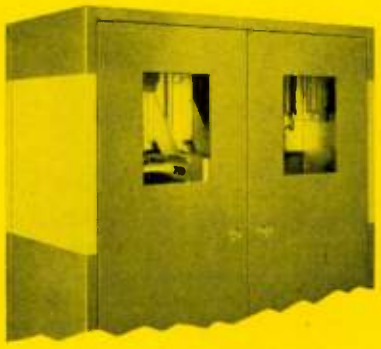
This new Westinghouse 10 kw transmitter utilizes many suggestions proposed by engineers in a recent independent survey of 162 FM applicants and engineers in 56 cities.

These suggestions covered everything from colors of the transmitter to tube visibility and interior parts layout. Combined with the working knowledge Westinghouse engineers have gained in operating five FM stations — a background unmatched by any other manufacturer — these ideas bring new advantages to modern transmitter operation.



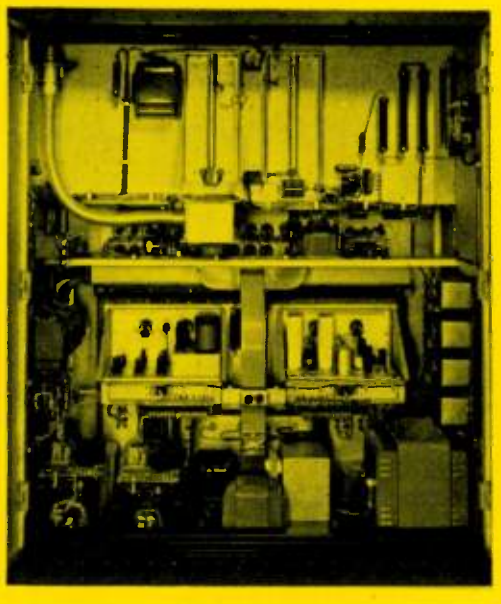
EXAMPLE:

The Frequency Modulated Oscillator, Low Power Driver and the Frequency Control Unit are mounted on standard relay rack chassis equipped with plug-in connectors for quick removal.



EXAMPLE:

Large windows in rear doors permit quick visual inspection of interior.



EXAMPLE:

Vertical open arrangement makes rear compartments easy to inspect and service.

EXAMPLE:

Supervisory control detects and locates outages instantly.

How well these new designs outstrip other types is shown by the comparative table on page 7 . . . only Westinghouse gives you *all* the advantages of improved transmitter operation.

New 270° easy-to-read meters are at eye level.

All doors, panels and windows opening to live circuits are equipped with interlocks and grounding switches.

Driver

High-voltage rectifier

R.F. power amplifier

Front view of 3-cubicle 10 kw FM transmitter. If "in-line" layout is undesirable, rectifier cubicle may be placed elsewhere. Subbase can be omitted, but it contributes to easier installation and alignment and inter-cubicle wiring can be handled through conduit within subbase. If rectifier cubicle is mounted away from exciter and power amplifier, subbase is not used.

Centrally-located control panels are easily accessible on all three cubicles.

THE 10 KW TRANSMITTER COMBINES ADVANCED CIRCUIT DEVELOPMENTS AND SOUND MECHANICAL DESIGN

The complete transmitter is enclosed in three heavy-gauge, sheet-aluminum cubicles that form an integrated, unified design when assembled. The left cubicle is the 3 kw FM transmitter, acting as a driver; center cubicle is the high-voltage rectifier and right cubicle is r.f. power amplifier.

Only five external wiring connections are needed to put the transmitter into operation:

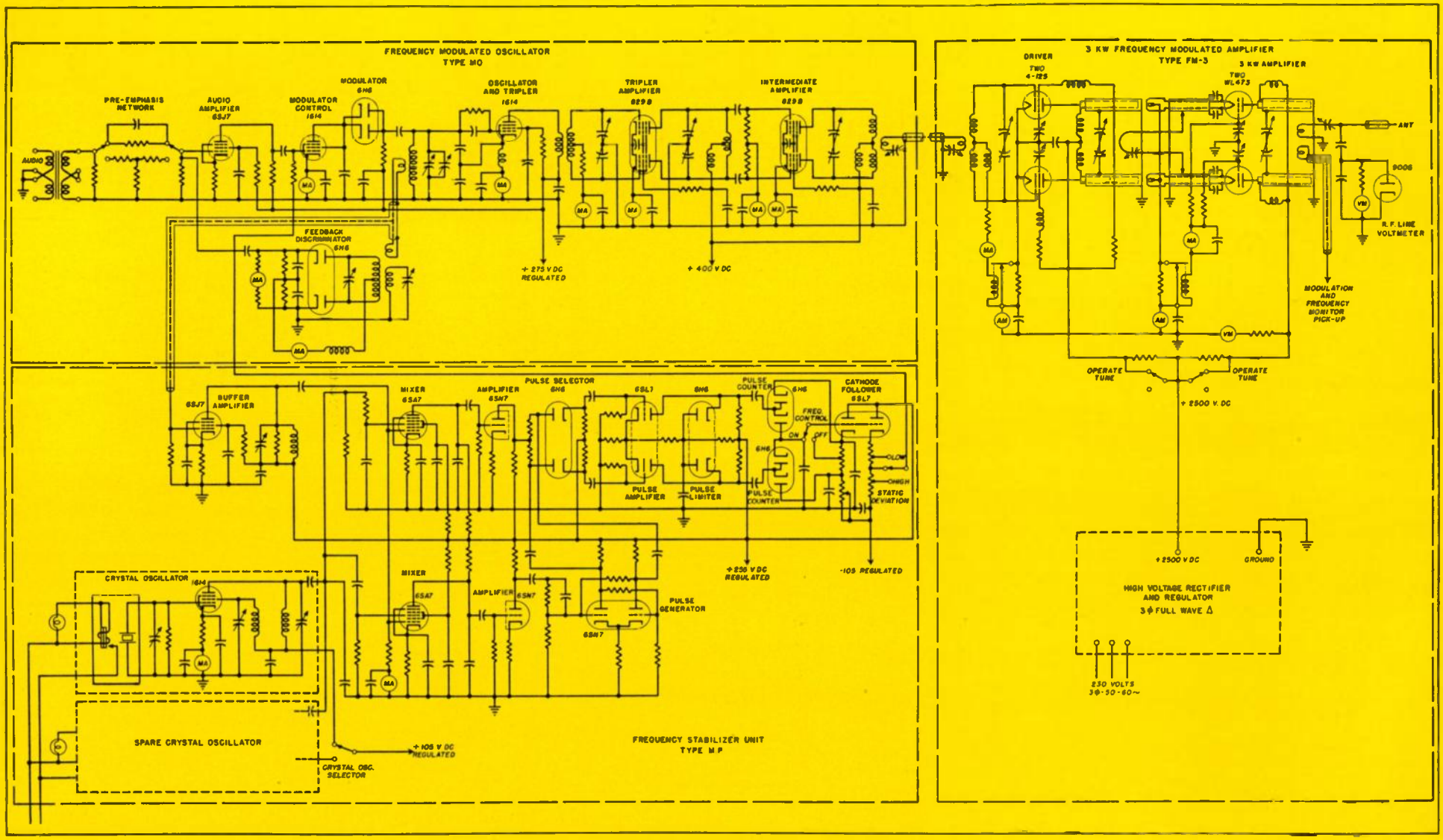
1. 208-240 volt, 3-phase power input.
2. 115-volt, a-c, power input for crystal heaters.
3. r.f. output for connecting modulation monitor and frequency meter.
4. program input.
5. coaxial line to antenna.

All doors opening to parts at dangerous potentials are interlocked for the protection of maintenance personnel. Glass panels in rear doors make inspection of interior easy while transmitter is in operation. The second intermediate amplifier and driver tubes, the intermediate voltage rectifier tubes and the high-voltage rectifier and power amplifier tubes are all visible through safety glass panels in the front of their respective cubicles.

The Type MO Frequency Modulated Oscillator and the Type MP Frequency Stabilizer Unit contain the low-power exciter stages and frequency stabilizing circuits respectively. These plug-in units may be removed easily from their position in the left cubicle.

12 PLUS FEATURES IN THE WESTINGHOUSE 10 KW FM TRANSMITTER

1. Direct generation of frequency modulation.
2. Crystal-derived, center-frequency stablization, independent of circuit tuning.
3. Transformer life practically unlimited; high-temperature Class "B" insulation — impervious to humidity and "aging".
4. Complete fuseless overload protection.
5. Automatic sequence starting.
6. WL-479-R tetrode-type tubes in the 10 kw power amplifier.
7. Supervisory control for immediate outage location.
8. Aluminum cubicles — light weight and better electrical shielding.
9. Easy maintenance — open vertical arrangement of components; large inspection windows in rear.
10. Tubes and components operate well below peak rating to insure long life.
11. Easily adapted for higher power by adding amplifier units.
12. One instrument for each key circuit; no instrument switching.



SCHEMATIC DIAGRAM, 10 KW FM DRIVER

HERE ARE THE IMPORTANT ELECTRICAL AND MECHANICAL SPECIFICATIONS . . .

ELECTRICAL SPECIFICATIONS

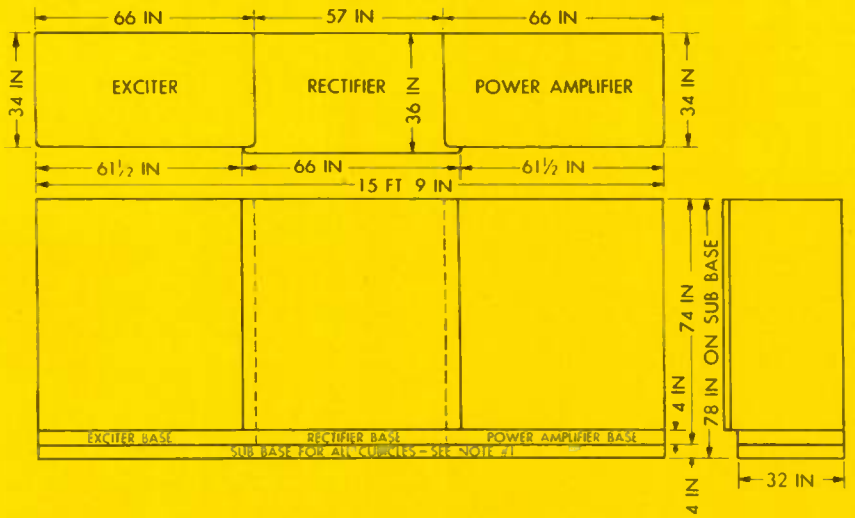
Carrier power output (nominal)	10,000 watts.
Carrier frequency (single specified frequency)	88 to 108 mc.
Frequency stability	Better than ±1,000 cps.
Output line impedance	51.5 ohm line in accordance with R.M.A. standards.
Modulation capability	±100 kc.
Audio frequency response (30 to 15,000 cycles)	Without pre-emphasis, ±1 db from response at 1,000 cycles; with pre-emphasis, ±1 db from 75 microsecond curve.
Audio input for ±75 kc carrier swing	+ 10 dbm at 400 cycles.
Audio input impedance	600/150 ohms.
Harmonic distortion (including all harmonics up to 30 kc at ± 75 kc swing)	Less than 1.0% rms for modulating frequencies between 100 and 7,500 cps. Less than 1.5% rms for frequencies between 50 and 100 cycles and between 7,500 and 15,000 cycles.
FM noise level	At least 65 db below ± 75 kc swing.
AM noise level	At least 50 db below 100% AM modulation.
Power supply	208-240 volts, 50 or 60 cycles, 3-phase; 115 volts, 50/60-cycle, single-phase for crystal heaters.
Power input	31 kw at 90% power factor for full output.

TUBE COMPLEMENT

Type MO Frequency Modulated Oscillator	
Audio amplifier	1 Type 6SJ7
Modulator control	1 Type 1614
Modulator	1 Type 6H6
Feedback discriminator	1 Type 6H6
FM oscillator/tripler	1 Type 1614
Tripler	1 Type 829B
Intermediate amplifier	1 Type 829B
Type MP Frequency Stabilizer	
Buffer amplifier	1 Type 6SJ7
No. 1 crystal oscillator	1 Type 1614
No. 2 crystal oscillator	1 Type 1614
No. 1 mixer	1 Type 6SA7
No. 2 mixer	1 Type 6SA7
Amplifier	1 Type 6SN7
Pulse generator	1 Type 6SN7
Pulse discriminator	1 Type 6H6
Pulse amplifier/limiter	1 Type 6SL7
Pulse limiter	1 Type 6H6
Balanced pulse counter	2 Type 6H6
Cathode follower	1 Type 6SL7
Voltage regulator	1 Type OD3/VR150 1 Type OC3/VR105
Bias rectifier	1 Type 6X5
Bias regulator	1 Type OC3/VR105
Low-voltage regulator	
Regulator	2 Type 6Y6G
Regulator control	1 Type 6SJ7
Control bias	1 Type OC2/VR105
Low-voltage rectifier	2 Type 866A
Intermediate voltage rectifier	6 Type 872A
Intermediate amplifier	2 Type 4-250
Driver amplifier	2 Type WL-473
R.F. voltmeter rectifier	1 Type 9006
Power amplifier bias rectifier	2 Type 5U4-G
High-voltage rectifier	6 Type 575
10 kw power amplifier	2 Type WL-479

MECHANICAL SPECIFICATIONS

Total over-all dimensions	189″ wide, 36″ deep, 78″ high
Side cubicle dimensions	66″ wide, 34″ deep, 74″ high
Central cubicle dimensions	66″ wide, 36″ deep, 74″ high (overlaps and cubicles)
Weight of exciter cubicle	Approximately 1,900 lbs.
Weight of power amplifier cubicle	Approximately 1,900 lbs.
Weight of high-voltage rectifier cubicle	Approximately 2,700 lbs.



✓ CHECK THIS LIST OF COMPARATIVE FEATURES

	FEATURE	MANUFACTURER (W)	A	B	C
1	Three-cubicle transmitter	✓			✓
2	No critically tuned band-pass circuits used	✓		✓	
3	No special test instruments required for tuning	✓			
4	Nonmicrophonic, diode-type tube modulation	✓			
5	5 R. F. stages or less	✓			
6	High-temperature (class "B" insulation) transformers (open dry-type throughout)	✓			
7	Only 2 stages of frequency multiplication	✓			
8	Frequency multiplication only 9 times or less	✓			
9	Frequency controlled without the use of dividers or locked oscillators	✓	✓		✓
10	Supervisory control system	✓	*		

* Manufacturer's data not available at time of this printing.

WESTINGHOUSE SUPPLIES OTHER EQUIPMENT YOU WANT

Westinghouse antennas and r.f. transmission lines are available, too. Westinghouse 10 kw FM transmitters operate into any suitable combination (R.M.A. approved) of r.f. transmission line and antenna within the 88-108 mc band.

Antennas are horizontally-polarized and can be supplied to fulfill the varying requirements of gain. The transmission line is coaxial pressurized type with solderless couplings. FCC required frequency and modulation monitors are also available.

. . . AND HELP IN APPLICATIONS

Westinghouse engineering and sales offices are ready to help you and your consulting engineer file your FM application by supplying information you need to complete it.

WESTINGHOUSE GIVES YOU THIS UNMATCHED BACKGROUND IN RADIO ENGINEERING AND OPERATION

The Westinghouse engineers who developed a host of important "firsts" in AM transmitter design have a total operating experience in FM of 23 years.

How well this background helps us design transmitters is shown by some of these exclusive Westinghouse "firsts" . . . metal rectifiers; unit cubicle construction; spare rectifier tube available by pushbutton operation; individual regulator for power amplifier plate volts; Fosterite insulation; supervisory control; Hipersil cores for transformers and reactors; multiple terminal connection to facilitate console operation.

For more information — or for help on any FM transmission problem — write, wire or phone your nearest Westinghouse office today.

WESTINGHOUSE HAS THIS OPERATING EXPERIENCE		
1.	KYW-FM (100.3 mc) has been operating for	4 years
2.	KDKA-FM (94.1 mc) has been operating for	4 years
3.	WOWO-FM (95.9 mc) has been operating for	4 years
4.	WBZ-FM (100.7 mc) has been operating for	5 years
5.	WBZA-FM (97.1 mc) has been operating for	6 years
	Total Westinghouse FM operating experience	23 years

Westinghouse

Electronics at Work

WESTINGHOUSE ELECTRIC CORPORATION

INDUSTRIAL ELECTRONICS DIVISION

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